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Usages

OUR progenitors counted things by their fingers, and when the practice came to be reduced to a system of notation it was naturally in groups of ten.

When they set up standards of measurement they divided them into twelfths or sixteenths so that they would be susceptible of successive halvings.

If they had had six or eight fingers the system of notation would have combined the advantages of the decimal and the duodecimal systems.

Now, instead of agreeing upon one or the other, we have an acrimonious struggle between them with increasing investments in both and greater cost and difficulty in unifying practice.

Fahrenheit established his thermometer with its zero at the lowest temperature that he was able to produce at the time. And millions of people use his unscientific scale today and cannot get away from it.

The Egyptians had a calendar of twelve months of thirty days each, taking up the extra days in holidays.

Julius Cæsar adopted the Egyptian calendar for the Roman empire, but discarded the feature of equal months and added a day to each alternate month, taking one from February to make up the needed six.

Augustus Cæsar, in order that his month should be not inferior to that of Julius, took another day from February and added it to August.

Further attempts at readjustment loaded the world with our present bungling system of dividing the years into months, quarters and halves of unequal lengths, with months that are not multiples of weeks and with the same dates falling upon different weekdays in succeeding years.

And then they got into the way of calling the time at which the sun passes over the meridian "twelve o'clock," and every degree of longitude had a different time until they bettered it somewhat by the use of time zones. There are only one-half as many hours on the clock as there are in the day, and they have to be distinguished as a.m. or p.m. or, on the railway tables, by light and black-face type.

Why not use a twenty-four hour scale and say "15 o'clock" instead of 3 p.m.?

And why not use Greenwich time all the way around? Noon at a given place would be when the sun was on the meridian. It would not be twelve by the local clock anywhere but at Greenwich, but nobody would need to go without his lunch on that account.

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Only Modernization Can Save British Industry

ENGLAND has coal, world supplies of materials, transport facilities, a favorable climate and intelligent workers, yet for years she has suffered hard times. What is wrong? A. J. T. Taylor, a leading industrialist, who has been studying British industry on the spot, has forwarded to *Power* a copy of a letter he wrote on the subject to Prime Minister Baldwin. England's manufacturers, says Mr. Taylor, are seeking government aid instead of working out their own salvation with modern equipment and modern production methods. "For the massive central problem of industrial depression there is only one remedy, industrial efficiency."

Those who read Mr. Taylor's "Profit and Production" in the January 8 number of *Power* will be glad to know that some of England's citizens, at least, see clearly the root of her difficulties. Never-ceasing modernization with constantly increased productivity of her workers, resulting in lower prices, higher wages and increased buying power, will unlock the treasure house of prosperity in England just as surely as they have done so in America.

Incidentally, the same may be said of certain backward industries in this country.

Safety Should be Made a Feature of Design

IT WOULD be difficult to overemphasize the importance of safety in power-plant design. If those responsible for the plant expect the men to take pride in its operation, they should demonstrate their interest by making it safe to operate. When a man must risk injury while inspecting or cleaning a piece of equipment, he should not be censured for avoiding the dangerous condition whenever possible. Neglect of equipment leads to unexpected breakdowns with serious interruption to service and expensive repairs.

Safety in plant design should be considered for the conditions that exist when making repairs as well as when the machines are running. A machine may be safe to operate but dangerous to repair. Such a condition usually increases the cost of repairs.

Equipment may be safe from the human viewpoint, yet it may be subjected to dangerous surroundings. Generators may not be properly protected against short-circuits and grounds, conductors may be installed in proximity to high temperatures, or machine windings and other parts may be exposed to moisture. These and a wide variety of other conditions exist in plants and eventually lead to serious breakdowns and expensive repairs that could have been avoided at small cost if a little foresight had been used.

Too frequently, hindsight and not foresight controls the expenditures for safety in plant designs. Attention is centered on what it will cost to make conditions safe rather than what may be the cost if something goes wrong. Many a machine has been wrecked and cost thousands of dollars to repair all because someone would not spend a very small part of the repair bill for adequate protection. Keeping down the cost of a plant does not necessarily produce the lowest-cost kilowatts at the switchboard.

The Loeffler "Steam-Pumping" Boiler

IN THE number of December 29, 1925, *Power* gave a preliminary description of the "fireless," or "steam-pumping," boiler invented by Professor Loeffler, of the Charlottenburg (Germany) Technische Hochschule, for the generation of high-pressure steam. Professor Loeffler's boiler is, in effect, a separately fired superheater placed in series with a steam-circulating pump and an unfired drum partly full of water. The pump forces bubbles of superheated steam up through the water in the drum, where their superheat is absorbed in the generation of additional steam. This automatically increases the pressure until steam equal in amount to that generated is drawn off from the circuit for outside use. An economizer in the setting with the superheater preheats the feed water going to the drum.

Two advantages of the Loeffler boiler seem clear. One is the elimination of heat-transfer through metal walls to boiling water. Impure feed water, with resulting deposits of scale in the drum, should not affect efficiency or capacity or lead to the burning out of metal walls. In the case of industrial plants with a high percentage of makeup this should be a marked advantage. The other advantage is the elimination of tube holes and tube-rolling strains from the drum, so that the walls can be made much thinner than the drum walls of standard high-pressure boilers. This points to a definite saving in the cost of the drum. The apparent disadvantages of the Loeffler boiler are connected with the operation of the steam-circulating pump.

By special arrangement with Professor Loeffler *Power* presents a rather extensive discussion of the problems involved in the generation of steam at high pressures and temperatures. This is in two sections. The first,

appearing in this number, deals with the general aspects of the problem and with various types of high-pressure boilers. The second and concluding section, to appear shortly, will deal primarily with the Loeffler boiler and outline results obtained with some foreign installations.

These articles very definitely argue that the Loeffler boiler is superior to all other types for high-pressure steam generation. Whether all the criticisms of other types and the claims made for the Loeffler boiler will stand searching analysis remains to be seen. It has seemed best to allow Doctor Loeffler to state his case as he sees it. His presentation is remarkably clear and will, it is hoped, lead to an animated discussion in the correspondence pages of *Power*. Readers in touch with high-pressure problems, whether they be equipment manufacturers or users, are invited to join in this discussion.

Over-Fire Air With Stokers

THAT combustible gases are evolved from the front of most stokers is well recognized. Unless thoroughly mixed with gases from other parts of the stoker which have excess oxygen, they will not be properly burned and will constitute a heat loss. Such mixing in a large modern furnace cannot be left to chance. The use of air jets in the fronts of furnaces is increasing. The question arises whether stoker performance should be modified so that the complete combustion of all such gases can be secured by the admission of over-fire air in such a way as to produce a degree of turbulence in the furnace comparable to that found desirable in recent powdered-coal furnaces.

In the case of chain-grate stokers the gases at the front of the stoker are largely products distilled during ignition of the fresh coal. With underfeed stokers the deep bed of fresh coal above the retorts at the front of the furnace tends to act as a gas producer and to dissociate the carbon dioxide and water vapor formed by combustion in the lower part of the bed. In both cases the unburned gases contain appreciable amounts of carbon monoxide and hydrogen. The reducing effect of these gases on the arch brick of the chain-grate stoker and on the side walls of the underfeed stoker leads to the formation of slags with the brickwork and fly-ash, at comparatively low temperatures. This may result in rapid destruction of this brickwork, in boiler outage, and in high maintenance charges.

The admission of air over the fuel and under the arch in the case of chain-grate stokers, oxidizes these gases and destroys their reducing action. Air admitted at the front and along the side walls of underfeed stokers has a similar effect.

Such air has a tendency to stratify under the arch and along the walls, and may not reach combustible gases in the center of the furnace. This has led to the use of air jets which issue at such velocity that they penetrate well into the furnace. The use of such jets is said to have reduced smoke, lessened slagging on the boiler tubes, and to have resulted in higher boiler efficiency.

In view of these accomplishments from the use of air jets, it seems possible that boiler operation may be improved by admitting a smaller proportion of the total air needed for combustion through the grate, thus leading to greater gas-producer action in the fuel bed and to lower fuel-bed temperatures. The remainder of the air may then be admitted above the fuel bed in such a manner as to produce the necessary degree of turbulence in the furnace to burn completely all the gases. This should produce high flame temperatures, high rates of heat generation per cubic foot of furnace volume, reduced stoker and furnace wall maintenance, higher boiler efficiency, and less slagging on the lower boiler tubes. It might call for modifications in stoker design and operation, but in view of the possible advantages, the plan seems worthy of a trial.

Mechanical Engineering Turns From Rule of Thumb

A DISTINCT difference, in attitude and method, between the fields of electrical and mechanical engineering has often been noted. Electrical engineering is, and always has been, "high brow" scientific and mathematical. It bears the stamp of the college physics laboratory, while mechanical engineering is still largely dominated by "rule of thumb." Many trained scientists, it is true, have left their marks on mechanical engineering practice, but they had to force themselves into the game from the side lines, whereas scientifically trained men dominated the electrical field from the very start.

But today, if one reads the signs of the times correctly, rule of thumb in mechanical engineering is rapidly losing ground as greater numbers of technical men assume leadership in the assault on unsolved and partly solved problems.

Looking around, one sees chemical knowledge replacing hit-and-miss boiler doping just as medical science has undermined the patent medicine. Metallurgy and metallography are finding ever broadening application in the mechanical field as new metals are developed for severe service. Chemistry and physics are called in to remedy the shortcomings of refractories. Complex heat-balance studies, higher pressures and other recent developments are forcing engineers to brush the dust from steam tables and treatises on applied thermodynamics. Electrified control apparatus is creeping in everywhere, calling more and more for engineers with scientific background.

Finally, the schools of mechanical engineering, many of them at least, are giving up the old attempt to turn out machinists and boiler designers, finding that they cannot make a job of this without neglecting the sciences fundamental to all engineering work. The strongholds of rule of thumb are rapidly yielding to an assault which will bring mechanical engineering—and power engineering, in particular—more fully under the control of men trained in scientific fundamentals and imbued with the scientific spirit.

Trenton Channel Station

Notice the cloud of coal dust before the installation of the filters

ELIMINATES POWDERED

Bag filter systems with automatic shakers and collectors on 24 cyclones eliminate dust nuisance at Trenton Channel Station. Cotton bags are used. To avoid wetting filtering material, the filter compartments, hoppers and ducts are heat-insulated and preheated air is added to the vent mixture before it enters the filter to keep the temperature above the dew point. Details of construction and operation and experience with fire hazards add interest to an installation regarded as an unqualified success.

TRENTON Channel Station of The Detroit Edison Company, one of the first large steam power stations to use pulverized coal exclusively, has been in operation since June, 1924. In line with design practice at that time the coal preparation equipment was installed as a "bin and feeder," or "storage," system housed in a building separate from the boiler house. The equipment of a central coal preparation system usually consists of crushed-coal storage bunkers, crushed-coal driers, pulverizing mills, exhauster fans and cyclone separators for air-separation type mills, and a transport system for delivering the pulverized coal to the various boiler storage bins.

The purpose of the coal driers is to reduce the moisture content of the coal to a point that will allow of transportation in the pulverized state without trouble from plugging of the transport system. For the type of transportation system used at Trenton Channel, the moisture content should not exceed 2 per cent.

Additional drying takes place in the mills, owing to evaporation of moisture from the pulverized coal resulting from the air-separation method of removal of the coal from the mill. On account of this constant addition of moisture to the air in the closed air circuit it is necessary that some air be vented out of the circuit to prevent moisture saturation and replaced with air of a lower moisture content by inleakage. To prevent unbalancing of the air circuit, the vent take-off is placed at a point in the system at which there is a slight positive pressure.

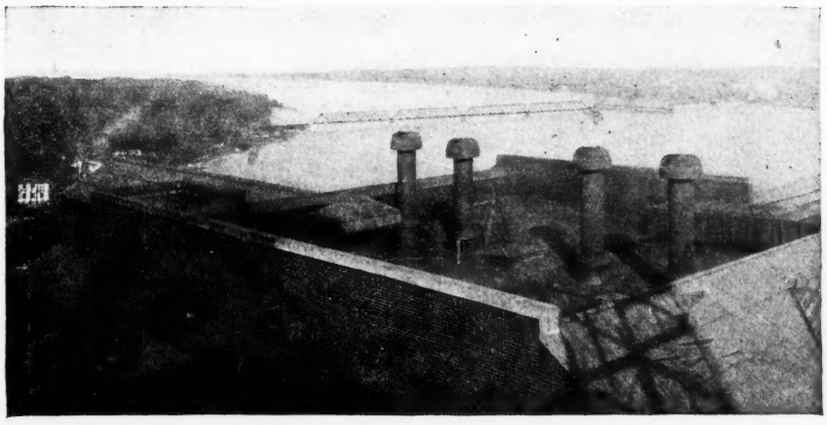
In the original layout at Trenton Channel the location of the vent take-off was in the U-bend of the return air pipe from the cyclone separator to the mill. The quantity of air vented off averaged about 800 cu.ft. per min. at a temperature of 125 deg. F. and a relative humidity that varied from 25 to 100 per cent, depending on the initial moisture content of the coal and the operation of the drier.

Concentration of coal in the vented air for the conditions noted, will vary from 6.5 to 22 grains per cubic foot, or 45 to 150 lb. per hour. In percentage of mill rated capacity this amounts to 0.375 to 1.25 per cent, which, of course, represents a direct loss in the amount of coal chargeable to the station. Beyond the fact that this coal represents a small but distinct loss in the heat chargeable to the station, is the appearance at the discharge of a cloud of dust during the period of operation of the mills.

At Trenton Channel the original design of the preparation house called for individual vent stacks to atmosphere from each mill cyclone. In an effort to reduce the dust these vents were repiped into the discharge air duct from the driers and then discharged, with the drier air, through an air washer and the drier exhauster air fan to atmosphere. Improvement in the appearance of the dust cloud was slight.

Another scheme, which was thought to have merit but did not prove satisfactory in operation, was the idea of drawing the drier and vent air through two cyclones in series.

Any method to be used for the collection of this dust may be installed with two results in view—recovering of the coal in a form ready for use in the pulverized-coal fired furnaces, or in a form that would necessitate further processing to make it ready for burning. The former method, of course, is preferable. In either case the re-



This photograph is the evidence that the filters were effective

COAL DUST

from Cyclone Vents

By H. E. MACOMBER
Engineer, Detroit Edison Company

covery may be divided into two general methods—that of complete recovery of all coal contained in the air, or partial or maximum perecentage methods of recovery. Again the former, or complete-recovery, method is preferable because the coal is so fine that it becomes necessary for any method of collection to result in practically complete clearance to give satisfactory visible evidence that the dust has been eliminated from the vent discharge.

Previous experience had shown that the source of this dust lay almost wholly in the vent discharge from the mill cyclone separators. For that reason it was assumed that any method found to be satisfactory in fulfilling the conditions would need to be applied only to the cyclone separator vents.

A plan that had been in use for dust collection in other industries and was thought to be adaptable to this problem, was the use of cloth bag filters. The principle of coal-dust collection by the bag-filter method is to pass the dust-laden air, or gas, through finely woven cloth bags at an average velocity of three or four feet per minute. The dust is deposited on the surface of the bag while the air is passed through the fabric. After a period of operation the dust may build up on the bag surface, thus increasing the resistance to flow of air through the bag wall. At such time the bag is cleaned by shaking it into a closed hopper. The principal aid to continued satisfactory operation of this type of collector is the prevention of moisture condensation in the filter, which tends to wet the bags and the collected dust, thereby closing the pores.

In June, 1928, bag-filter equipment was installed for trial on the vent from one mill cyclone separator. This set consists of two duplicate sheet-steel filter-compartment cylinders, each containing eighteen cotton filter bags approximately 8 in. in diameter and 8½ ft. long. Each compartment is set over a conical-shaped hopper which has a "flapper" coal discharge valve in the bottom. One end of each bag is located at the bottom of the compartment and is clamped with a ring about a thimble forming an opening from the hopper through the bottom plate of the compartment. The upper, or closed, end of each bag is fastened with a clamping ring to a plate. These plates are in turn hooked to a spider suspended by one rod passing through the center of the cover plate, or end of the compartment, to the bag-shaking mechanism.

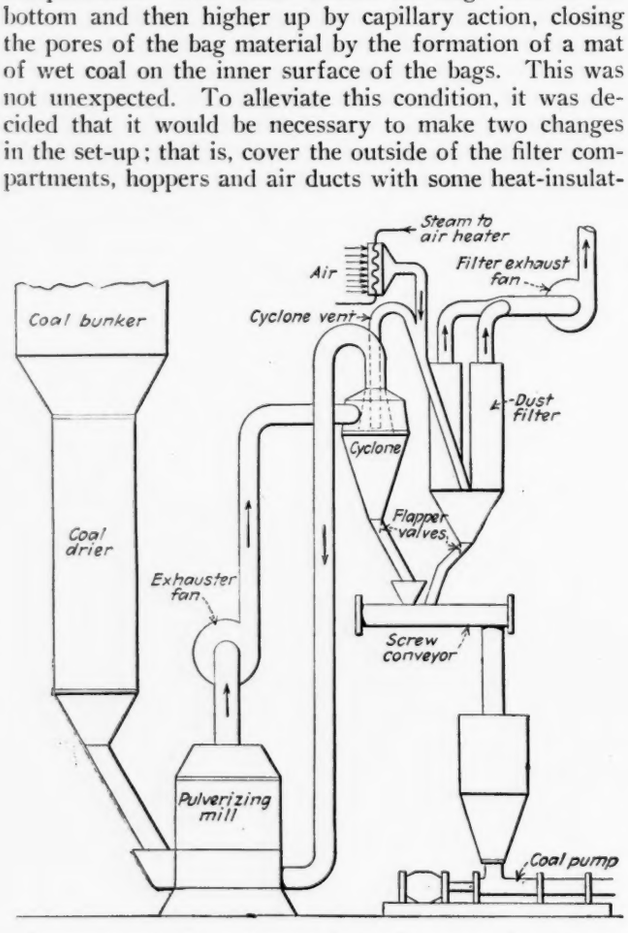
The air and coal mixture from the cyclone vent, which is drawn through the filter by a small exhauster fan as shown on page 466, enters the compartment hoppers below the bottom plates or bag ends, and passes upward into the bags. The clean air passes through the bag fabric to the outlet manifold and then to the fan.

Located on top of the compartments is the bag-shaking mechanism, operated intermittently by compressed air. Air admission to the compressed-air cylinder and the consequent timing of shaking is regulated by a motor-driven valve. Opening and closing of the valve ports regulates the flow of air to the shaking mechanism cylinder and also to a small auxiliary cylinder that operates a damper closing the clean-air discharge line from the filter to the exhauster fan and opening the compartment discharge to atmosphere during the period of shaking. By closing a damper at this point, the flow of air through the bags to the fan is stopped and a slight reverse flow of air from the atmospheric damper is started through the bags and into the other compartment, thus permitting the bags to hang limp during the shaking period. This allows the dust to fall to the hopper below without being drawn toward the bag walls, which would be the case if air were constantly being drawn through the filter by the fan.

The bags in the two compartments are shaken at alternate periods; that is, while the bags in one compartment are being shaken and the air flow through the bags

is reversed, the other compartment takes care of the total quantity of vent air mixture plus the air entering through the atmospheric opening. The duration of the shaking period is about five seconds.

After the trial installation had been in operation for a short time, it became necessary to shut down owing to an accumulation of water on the bottom plate of the compartment. The water wetted the bags first at the bottom and then higher up by capillary action, closing the pores of the bag material by the formation of a mat of wet coal on the inner surface of the bags. This was not unexpected. To alleviate this condition, it was decided that it would be necessary to make two changes in the set-up; that is, cover the outside of the filter compartments, hoppers and air ducts with some heat-insulating material, and add preheated excess air to the vent mixture before entering the filter, to keep the temperature of the air in the filter above the dew point.



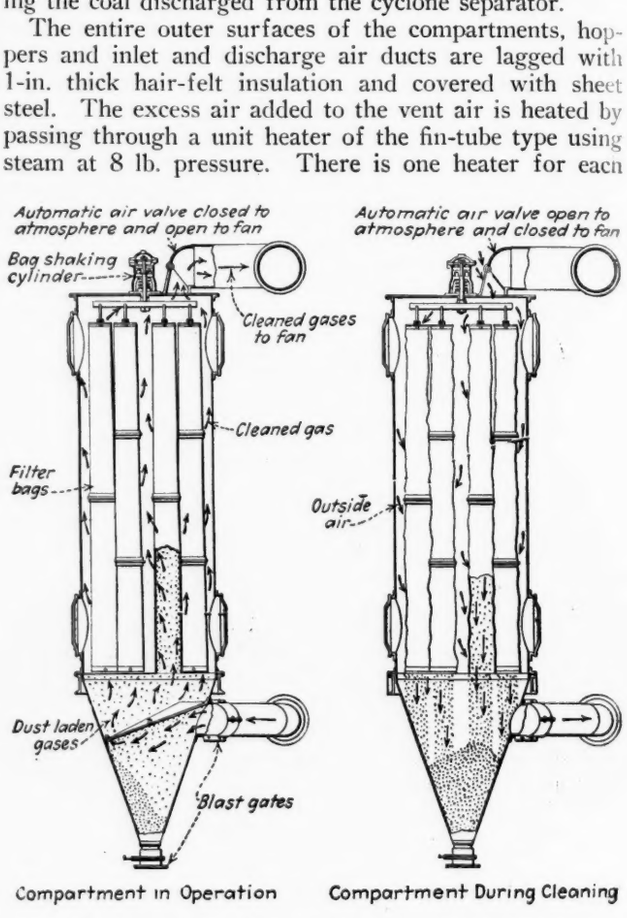
Arrangement of equipment in coal preparation house

This was done and resulted in satisfactory operation. There was no more trouble from condensation causing wet bags and plugging of the hopper discharge. Inspection of the air discharged from the exhauster fan indicated that clearance of the dust was practically complete, as the only time it was possible to detect any dust in the discharge was immediately after a shaking period, for a few seconds, when a slight haze could be seen. Results of a five-hour test conducted at that time are given in the accompanying table.

From these results it was decided that the bag-filter method of dust collection would be satisfactory for regular operation and that all mill and coal-breaker dust-collector cyclone vents should be equipped. The work was started Aug. 1, 1928, and finished three months later. The total installation for the coal preparation house includes filter units for 22 mill cyclones and two coal-breaker dust-collector cyclones.

These filters, installed in pairs on each vent for permanent operation on the mill cyclones, are modified somewhat in size and arrangement from those tested, to permit of installation in the space available. The new filters use twelve bags in each of the two compartments in place of the eighteen used in the trial set-up, with a proportional reduction in bag surface area. The compartments are consequently somewhat smaller in diameter. One common hopper with one coal-outlet flapper valve is used. The coal collected is discharged directly by gravity to either one of two main screw conveyors carrying the coal discharged from the cyclone separator.

The entire outer surfaces of the compartments, hoppers and inlet and discharge air ducts are lagged with 1-in. thick hair-felt insulation and covered with sheet steel. The excess air added to the vent air is heated by passing through a unit heater of the fin-tube type using steam at 8 lb. pressure. There is one heater for each


Automatic air valve closed to atmosphere and open to fan
Automatic air valve open to atmosphere and closed to fan
Bag shaking cylinder
Cleaned gases to fan
Cleaned gas
Filter bags
Outside air
Dust laden gases
Blast gates
Compartment in Operation
Compartment During Cleaning

Cross-sectional views of filter compartments

cyclone vent line. Each set has its individual shaking mechanism and exhauster fan. The fans discharge through manifolds and stacks passing through the building roof.

At the time of installation of these filters the vent-pipe location was changed to the center, or vortex, of the cyclone. When this location is used, the amount of coal carried off with the vent air is reduced to about 20 per cent of that from the original vent. The smaller amount of coal carried over with the vent air permits lengthening of the period between shakings to fifteen minutes.

Filters installed on the coal-breaker dust-collector cyclone vents consist of three 18-bag compartments for each vent. No additional preheated air was necessary inasmuch as the temperature of the vent air is above the dew point at all times. Additional filter capacity was provided, however, because the quantity of air vented from one of these cyclones is about 3,500 cu.ft. per minute.

The accompanying photographs show conclusively the effect that the filters have had in eliminating the cloud of dust from cyclone separator vents at Trenton Channel. The idea might be prevalent among some plant operators that the potential fire hazard and damage re-

sulting from fire in these collectors might offset any advantage gained through operation. It is our opinion that although the fire hazard may be greater, owing to the presence of the cotton bags, the actual possibility of fire is little more than would be the case with other collecting apparatus. Wool bags may be used in place of cotton bags. They are less inflammable, but are understood to be less efficient in the collection of dust, especially when first put into service.

During the first five months of operation of the filters, two fires have occurred. The first took place in a new filter after two days' operation. The second fire occurred in a filter after about four months.

Fire may start in the filters from one of three possible causes: (1) From sparks or pieces of incandescent coal that might be carried through the milling and separation process into the filter bags; (2) heating of coal in the filter hopper as a result of plugging of the discharge; (3) fire that might start from a static electricity discharge from the bag fabric to ground. In the first case it is probable that any incandescent particles of coal may enter the filter only when there has been trouble due to heating in the driers or crushed-coal bunkers. The second cause may be avoided entirely by daily inspection of the filter hoppers. It is thought to be the reason for the second fire mentioned. The third cause seems to offer the most probable reason as a fire hazard, but is a danger that is considered remote, inasmuch as static electricity accumulates to a dangerous extent only in dry atmosphere. In the filters no attempt is made to have either the coal or air in a dry state during regular operation.

The system was put in by the Dust Recovering & Conveying Company, of Cleveland.

RESULTS OF TEST ON BAG FILTERS

	Dry Bulb, Deg. F.	Wet Bulb, Deg. F.	Humidity, per Cent	Grains Moisture per Cu.Ft.	Dew Point, Deg. F.	Temp. Air Lve. Heater, Deg. F.	Temp. of Vent and Heated Air, Deg. F.
Cyclone vent line	131	118	68	32	116	191	147
Filter inlet	140	113	44	25	110	...	...
Filter outlet	117	104	64	21	102	...	...
Fan outlet	111	103	75	21	101	...	...
Room air	80	69	59	6	64	...	...

Static pressure in. water:	
Cyclone vent	+0.39
Filter inlet	—0.34
Filter outlet	—0.63
Fan suction	—0.63
Total air through filter, c.f.m.	1,150
Coal collected, lb. per hr.	45
Steam to air heater, lb. per hr.	60
Sieve analysis of collected coal:	
Per cent through 200-mesh screen	99.2
Per cent through 150-mesh screen	99.4
Per cent through 100-mesh screen	99.6
Per cent through 65-mesh screen	99.8
Per cent through 48-mesh screen	100.0

Squirrel-Cage Induction Motors for Boiler-Feed Pump Drives

By R. R. Sheely

Motor Engineer,
Westinghouse Electric & Manufacturing Company

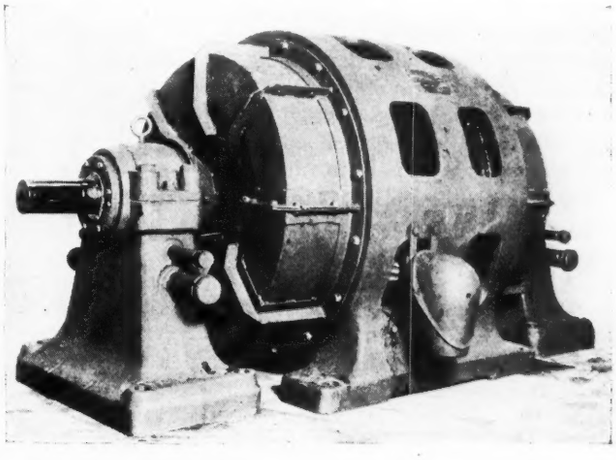
DEMANDS for large amounts of electrical energy at the lowest cost have caused a continual increase of boiler pressures up to 1,200 lb. on several of the latest installations. This increased pressure imposes an added load on the boiler-feed equipment, demanding an excessive number of pump stages or high operating speed. A speed of approximately 3,600 r.p.m. was chosen, as this is the highest speed at which an induction motor can be designed for operation on a 60-cycle circuit.

The speed of an alternating-current motor is determined by the frequency of the circuit and the number of poles. The synchronous speed, in revolutions per minute, equals 120 times the frequency of the circuit, in cycles per second, divided by the number of poles in the motor. Then a two-pole motor on a 60-cycle circuit will have a synchronous speed of $(120 \times 60) \div 2 = 3{,}600$ r.p.m.

Six-stage, 800-gal.-per-min. pumps are required on the latest installation by the Kansas City Power & Light Company. The driving motors are rated 900 hp., 2,300-volt three-phase 60-cycle, 3,550 r.p.m., with special squirrel-cage rotors to limit the starting current for normal starting on full voltage.

A motor of this rating and type presents several interesting design problems. In order to secure reasonable centrifugal stresses, a small-diameter rotating element is imperative with a relatively long core to give the necessary volume of material. This small-diameter rotor practically prevents the use of radial ventilation, and axial ventilation similar to that of medium-sized turbine-generators must be used.

The ventilating air is drawn in at each end by blowers mounted on the shaft, flows over the end turns of the



Squirrel-cage motor rated at *900 hp., 3,550 r.p.m. for driving a boiler feed pump*

This motor is designed for 2,300-volt operation and full-voltage starting.

winding and through axial ducts in the stator and rotor cores to a central radial duct, where it is discharged from the machine. In this way the axial ducts in the rotor are required to carry only sufficient air to cool the rotor and are, therefore, relatively small, permitting the use of a large-diameter shaft to give sufficient stiffness to insure smooth operation.

Once a motor of this type is properly balanced and installed, the only parts that are subject to wear are the bearings. By using forced-feed lubrication, a supply of clean cool oil to the bearings at all times insures reliable operation.

The high velocity of the ventilating air creates a reduced pressure area around the inner end of the bearing, with the resulting tendency to draw air through the housing. If this is allowed to take place, some of the oil spray present will be carried into the motor and deposited on the windings with the resulting danger of insulation failure. By arranging an air chamber at the inner end of the bearing and a connecting bypass to a point where the pressure is the same as at the outer end, the tendency for air circulation through the bearing is prevented. This, combined with the use of airtight seals on all other openings, prevents the leakage of oil.

THIRTY YEARS

OF THE

Diesel Engine

By L. H. Morrison
Associate Editor, Power

AN INSPECTION of Fig. 1, showing the yearly sales of Diesel engines, should convince even the most doubting that the Diesel has become the leading prime mover for plants other than those of large capacity or those using large quantities of steam. The sales in 1928, totaling 440,000 hp. excluding semi-Diesel and other low-compression engines, represent an increase over 1925 of 30 per cent, much greater than the increase in steam engines and steam turbine sales.

It was not until 1921 that the Diesel showed any great activity, although since 1914 there has been a steady increase in the use of this prime mover.

The first Diesels sold in the United States were two 10x20-in. single-cylinder units that were installed in the plant of the Long Arm System Company, Cleveland, Ohio, in 1900. The largest Diesel built in 1928 was the 4,000-hp. Busch-Sulzer unit for a Tucson, Ariz., power plant. The first Diesel central station was put in at Jewett City, Conn., in 1902, consisting of two 75-hp. units. In 1928 the largest Diesel central station in the United States was that of the Tucson Gas & Electric Company, Tucson, Ariz., made up of two 4,000-hp., two 1,000-hp. and two 500-hp. engines, a total of 11,000 horsepower.

In Fig. 2 the engines have been separated into four general classes—air injection and solid injection, divided into two- and four-stroke-cycle types. This chart does not go back farther than 1921, but prior to that time the engines mainly used were air-injection, with the four-stroke cycle predominating. There is a lack of agreement between Figs. 1 and 2, due to the inability of placing some 20,000 hp. into the proper divisions.

Since 1921 the solid-injection engine has received the greater attention from designers and manufacturers. This has been due chiefly to two reasons: The solid-injection engine meets the requirements of the small-power stations, as mechanically the engine is simple, and usually it sells at a lower price than does an air-injection engine.

The two-stroke-cycle solid-injection engine is built by

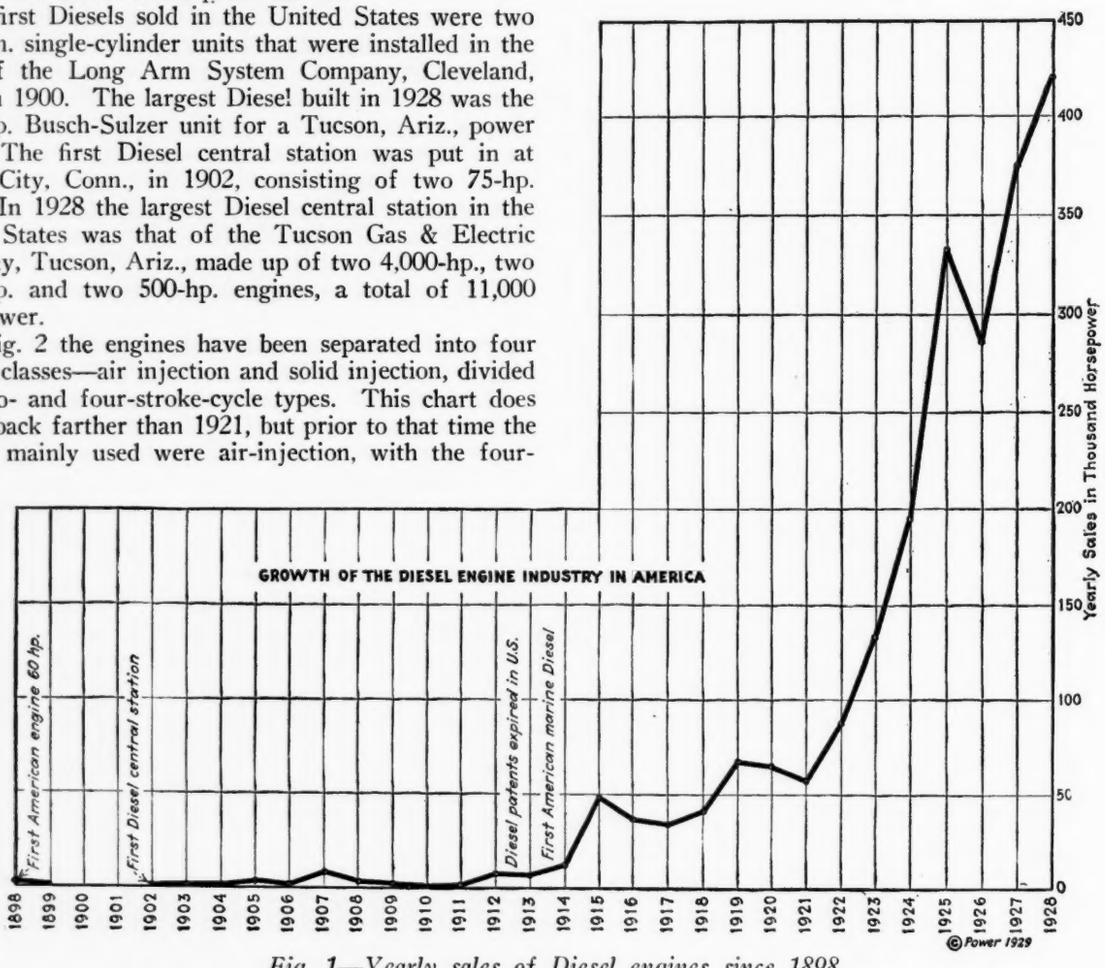


Fig. 1—Yearly sales of Diesel engines since 1898

four manufacturers, although ten other firms build solid-injection engines of the hot-surface, or semi-Diesel type. However, of the solid-injection two-stroke-cycle Diesel builders the output shown in Fig. 2 is mainly from one factory.

Four-stroke-cycle solid-injection engines are built by twenty manufacturers, but of these four do over 50 per cent of the business. The development of this type has been peculiarly along American lines. In 1914 the late W. T. Price embarked on the investigation that led to the evolution of the Price engine. This is the separate-combustion chamber, two-nozzle design now used by two firms, while a third firm makes use of a somewhat similar construction.

A second development was along the lines of substituting pump pressure for air pressure in the spray valve

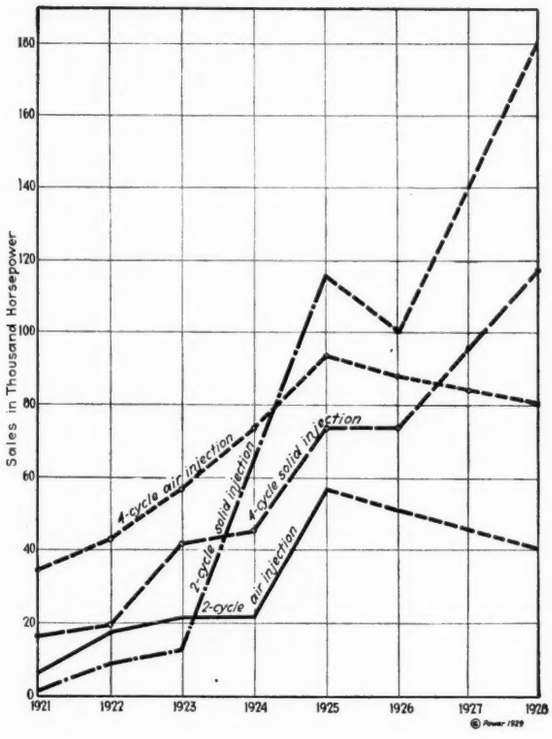


Fig. 2—Diesel engines classified by types

and of injecting the oil spray directly into the cylinder space. The first of these engines, making use of mechanically operated spray needle valves and pump pressures, was produced in 1921 and was a purely American product.

A third development, used by the majority of builders of four-stroke-cycle solid-injection engines, included the use of a separate pump to feed fuel to each working cylinder and the use of a simple check-valve nozzle. There are a number of design variations in the several engines as concerns the type of fuel pump, the pressur carried, the nozzle design and the shape of the pistor head.

The two-stroke-cycle air-injection engine shows a decline from 1925. This is due to the fact that this type is suitable especially for larger capacities, and the large engine has not had the same acceptance in the United States as has the smaller Diesel of below 750 hp. but there is reason to believe that this type of engine will show a steadily increasing application in the near future in plants using 5,000 horsepower.

Prior to 1912 all Diesels built in the United States were of the four-stroke-cycle type, but since that year, while a number of builders have engaged in constructing this type—seven at the present time—the other types have intrigued more firms.

While it has been impossible to segregate engine output since 1925 as to the industries into which they have gone, apparently 18 per cent of all engines built since 1904 are in central stations, 26 per cent serve oil pipelines, 26 per cent are in such marine installations as motorships, tugs, barges, tankers, etc.; 5 per cent are in refrigeration plants, and 31 per cent in such industries as textiles, flour mills, mines, etc.

There is every reason to feel that the Diesel output will continue to grow. At present it must be confessed that too many manufacturers are in business. The result is that prices are shaved to a point where profit disappears. With fewer factories engaged in the engine building, those continuing to run could be filled to capacity, which would decrease the overhead costs and lead to lower sales prices. Low prices would in turn increase the demand.

For the Note Book

By E. J. Jordan

Diameter of a circle $\times$ 0.887 = side of a square of equal area.

Side of a square $\div$ 0.887 = diameter of circle of equal area.

If distance across the corners of a hexagon is D and the distance across the flats of a hexagon is d, then $D = 1.155\,d$ and $d = \frac{D}{1.155}$

A steel plate one-quarter inch thick and one foot square weighs 10 pounds.

The distance across the flats of a hexagon or square nut = $1\frac{1}{2}$ times the diameter of the bolt plus $\frac{1}{8}$ inch.

The diameter of a bolt is equal to the height of the nut.

The correct size of drill to use when drilling a hole that is to be tapped for a bolt thread or pipe thread can be found by using a nut or a pipe fitting as a gage in choosing the drill. To drill a hole for a $\frac{3}{4}$-in. bolt tap, choose a drill that will fit snugly into the hole in a $\frac{3}{4}$-in. nut. Similarly, for a $\frac{3}{4}$-in. pipe the drill should slip into a $\frac{3}{4}$-in. fitting.

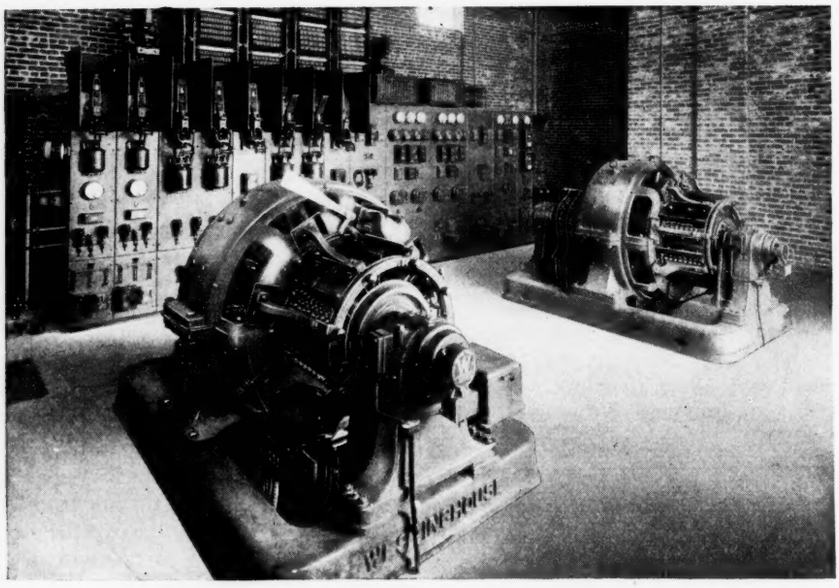
A mile a minute should be the maximum speed for a belt; a lower speed is more efficient.

A mile a minute is a good peripheral speed for ordinary grinding wheels.

A mile a minute is a good peripheral speed for a circular wood saw.

If the distance across the corners of a square is E and the distance across the flats is e, then

$$E = e \times 1.414,\ e = \frac{E}{1.414}$$



Two 1,000-kw. rotary converters controlled automatically

Safe Operation of ROTARY CONVERTERS

requires the interlocking of the alternating-current and direct-current circuit breakers; an overspeed device; direct-current reverse-power protection; protection against starting with the brushes on the commutator and to prevent closing the direct-current circuit breakers with the brushes off the commutator

By R. E. POWERS

General Engineer,
Westinghouse Electric & Manufacturing Company

TO SECURE satisfactory results from synchronous converters it is essential that they be properly applied and that the switching equipment protect the units from service faults and disturbances. Proper indicating devices to show the character of both the alternating-current and direct-current loads are essential.

The alternating-current machine breaker should be of the over-current automatic type, adjusted for inverse-time or definite-time trip, depending on the application. Where selectivity is desired between opening the direct-current feeder breakers and the alternating-current machine breaker, a non-automatic alternating-current breaker equipped with a shunt-trip or direct-trip attachment is necessary. To trip the breaker, the impulse is secured by the action of sensitive induction-type over-current relays that have definite minimum inverse-time characteristics.

In general, the setting of the alternating-current machine breaker may be relatively high, it being satisfactory to work at any value within the guaranteed momentary capacity of the machine. The alternating-current and direct-current machine breakers must be electrically interlocked in such a manner that the latter will be opened when the alternating-current breaker opens.

On the alternating-current machine breakers the undervoltage release should be adjusted to operate at as high a voltage as is practicable. It is essential, especially for a commutating-pole converter, to disconnect the unit from the line when the alternating-current voltage drops an appreciable amount. The restoration of normal voltage presents conditions similar to switching the converter from the starting to the running position with its brushes on the commutator, under which condition a flash may result.

The direct-current machine breaker should be equipped with an over-current tripping mechanism in which a definite minimum time-element may be introduced. The feeder breakers should be equipped with a series-type instantaneous-trip mechanism. Synchronous converters will commutate very large momentary currents if the

direct-current machine breaker does not open, but they will flash with no greater current if the breaker is opened.

In multiple-feeder stations, the selective action between opening of the instantaneous-type feeder breaker and time-delay machine breaker tends to eliminate flashing when heavy loads are dropped. During this period the current required by the remaining feeders tends to neutralize the excessive alternating current required to restore the rotor to its normal-load position.

In normal operation the selective action between opening of the machine and feeder breakers may be sufficient to prevent the former opening on faults that are readily isolated by disconnecting the defective feeder. In a single-feeder station the time element between opening of the two breakers is of no value, as tripping the feeder breaker ruptures the entire machine current.

Practically all synchronous converters are equipped with a centrifugal overspeed device mounted on an extension of the mainshaft. The overspeed device must be connected to open the alternating-current machine breaker should the machine overspeed, which in turn will open the direct-current machine breaker and isolate the unit.

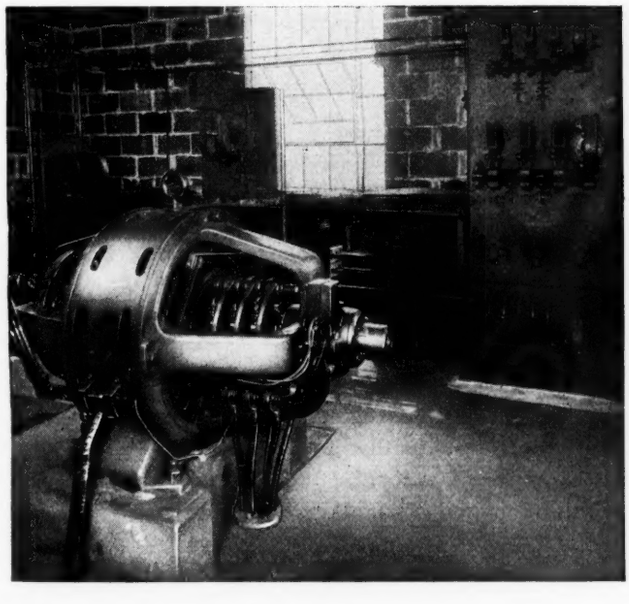
Directional Power Relays

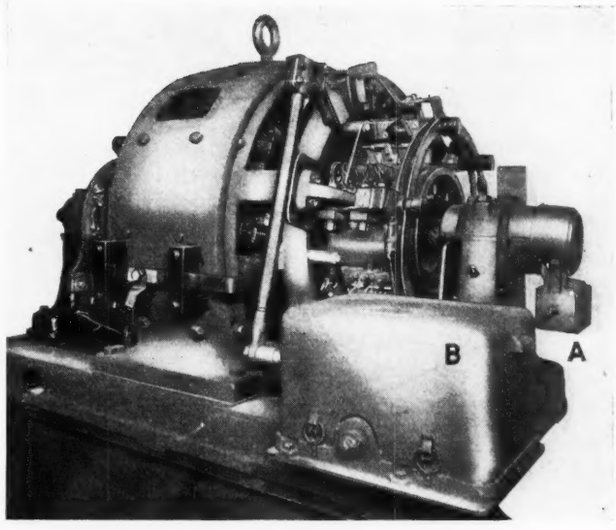
A directional power relay must be provided to prevent motoring from the direct-current end should the alternating-current voltage fail or the bus voltage rise above that of the machine. Reverse-power protection must be secured by a relay capable of standing full power flow in the positive direction and sufficiently sensitive to close its contacts on a reverse current that would motorize the converter. The operating contacts of the reverse-power relay must be connected to open both alternating-current and direct-current machine breakers on reversal of power flow.

With alternating-current, self-starting, commutating-pole-type converters it is necessary to raise the brushes from the commutator to prevent their arcing and burning during the starting period. It is recommended that the brush-lifting mechanism be electrically interlocked so that starting voltage cannot be applied to the converter until the brushes are raised from the commutator.

The brush gear should also be electrically interlocked with the direct-current machine breaker to prevent its being closed, after a converter is up to speed and voltage, until the brushes have been lowered upon the commutator. Closing the direct-current breaker with the brushes off the commutator overloads the small pilot brushes, which are in contact with the commutator during starting.

Alternating-current control equipment for the converter is shown on the right





A is the overspeed limit switch and B the brush-lifting equipment

Synchronous converters up to 1,500 or 2,000-kw. capacity are generally started from the low-voltage taps in the secondary windings of the transformers. Because of the heavy current involved, the starting and running breakers required for tap starting of large synchronous converters are heavy and expensive. Star-delta switching for large units is more economical in many instances. This method provides for connecting the transformer primary windings in star to supply 58 per cent normal voltage for starting and switching the connection to delta to obtain full running voltage.

Star-Delta Method of Starting

With the star-delta method of starting, the star or starting voltage will always be 30 deg. out of phase with the delta or running voltage. It is important that the connections be so arranged that the star voltage will lead rather than lag the delta voltage. Thus, during the period between opening the starting breaker and closing the running breaker, the machine's armature should drop back in phase position to correspond with the line voltage when the running breaker is closed. Without other timing than that inherent in the breaker's operation, the transition from star to delta is effected smoothly on many 60-cycle converters. Because of the larger actual time required for the armature to drop back 30 electrical degrees in a 25-cycle converter, it has been found necessary to interpose additional time delay in the control circuit of the running switch.

It occasionally happens that the switching and control equipment is not close to the converter rheostats. In such cases rheostat settings can be conveniently determined by signal lamps connected to auxiliary contacts on the rheostat faceplate. Position indicators are recommended where the rheostats are not readily seen by the operator controlling the converter.

Sufficient indicating equipment is required with any converter installation to check its operating conditions readily. A direct-current ammeter and voltmeter are

essential. Recording instruments are desirable in some cases. Reactive volt-ampere meters are recommended as being the most satisfactory means of indicating the phase angle between the supply voltage and current at the slip rings.

Synchronous converters are designed to operate at unity power factor and should be operated to secure the best results. In applications such as railway and mining, where the load varies rapidly, the field strength should be adjusted so as to secure unity power factor at the average load. For stations with low load factor it is recommended that the field strength be adjusted to produce unity power factor at a value between three-fourths load and full load.

Automatically Controlled Converter

Automatic switching equipment to control and protect synchronous converters protect the machine against:

1. Reversed, single, or low-voltage conditions in the power supply.
2. Unbalanced current due to supply-line defects or internal fault in the machine.
3. Alternating-current overloads.
4. Direct-current short time and sustained overloads.
5. Overheating of the machine windings.
6. Field failure.
7. Incomplete start.
8. Starting with brushes on the commutator.
9. Closing of the direct-current breaker before the brushes have been lowered to the commutator.
10. Overheated bearings.
11. Complete opening of fault current in one step by the opening of the load-shifting equipment to insert resistance in the circuit before opening of the feeder breaker.
12. Flashover. In case of flashover the unit is locked out of service.
13. Connecting to the direct-current bus with the converter polarity reversed. A polarized motor relay operates to check the polarity and to correct it if necessary before the sequence of operation can be completed.

Automatically controlled converter equipment started by the star-delta method has a time element in the switching sequence to allow the converter to drop back 30 electrical degrees after the star connection is opened before closing the delta.

Booster-type converters that are automatically controlled on Edison or electrolytic power systems are equipped with voltage and current regulators. The converter voltage is regulated by the voltage element of the regulating equipment that operates to control the booster element. When the load exceeds the machine's capacity, the current element takes preference and controls the booster field to supply constant current.

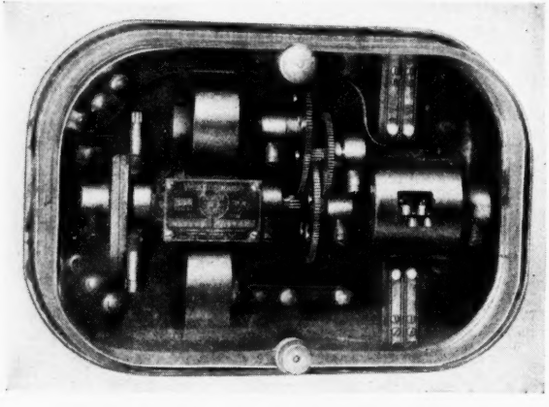
In no case should the machine be grounded by connecting it solidly to the negative lead or terminal. Such a connection renders the machine liable to unnecessary damage in case of a flashover or other ground to the frame, as the fault current is limited only by the low-resistance arc and machine winding.

On automatically controlled equipment it has become standard practice to ground the machine's frame through a 100-volt shunt trip coil on the emergency breaker or through a 120-ohm resistor for manually operated equipment. In case of flashover to ground, the resistance of the coil limits the current to a few amperes and the drop across the coil reduces the voltage tending to sustain the arc to a low value. Consequently, the arc to ground is weak and unstable and does little or no damage.

Limiting the ground current to a low value reduces the gases, owing to vaporizing the commutator copper at a point where the arc is established between commutator and ground. This will, in many cases, prevent the arc spreading and a flash between brush arms.

The trip coil or resistor should preferably be connected to the station ground plate. A connection to the negative lead is permissible and may be necessary when the rail ground resistance is high, as in the case of a dry-rock ballast.

In equipments using the series-type flash relay, care must be exercised to insure low enough resistance in the ground circuit to permit the relay to operate. If connected to the station ground plate, the resistance measured from the frame to the negative terminal should fall within the limits of two to four ohms, for all weather conditions. When these conditions cannot be met, the frame should be connected through the relay and a three-ohm resistance in series to the negative lead.



Polarized relay used to check the polarity of automatically operated converters

Better Use of Byproduct Power

An article in the March 26 number of *Power* will describe the 425-lb. boiler and 400-lb. turbine recently installed in the Racine, Wisconsin, plant of the Ajax Rubber Company. The 1,500-kw. turbine bleeds to the old steam mains at 170 lb. pressure and exhausts to process at 85 lb. At one-third load this installation generates byproduct power for 0.66 cent per kilowatt-hour, including all charges. At full load a kilowatt-hour will be generated for 0.36 cent. Modernized plants such as this are blazing the trail to that better use of byproduct power which will substantially reduce manufacturing costs in many American industries.

Chart for Finding Heat Loss Due to Incomplete Combustion

By C. A. Kulmann

THIS nomograph makes it possible to determine the loss of heat in boilers due to the combustion of the carbon in the fuel to carbon monoxide instead of carbon dioxide, and is at the same time both quick and accurate. The equation upon which it is based is the usual one,

$$L = 10{,}160 \times C \times \frac{CO}{CO + CO_2},$$

where L is the loss in B.t.u. per pound of dry fuel, C is the carbon burned, CO is the percentage of carbon monoxide in the flue gas and CO_2 is the percentage of carbon dioxide, the latter two values being volumetric.

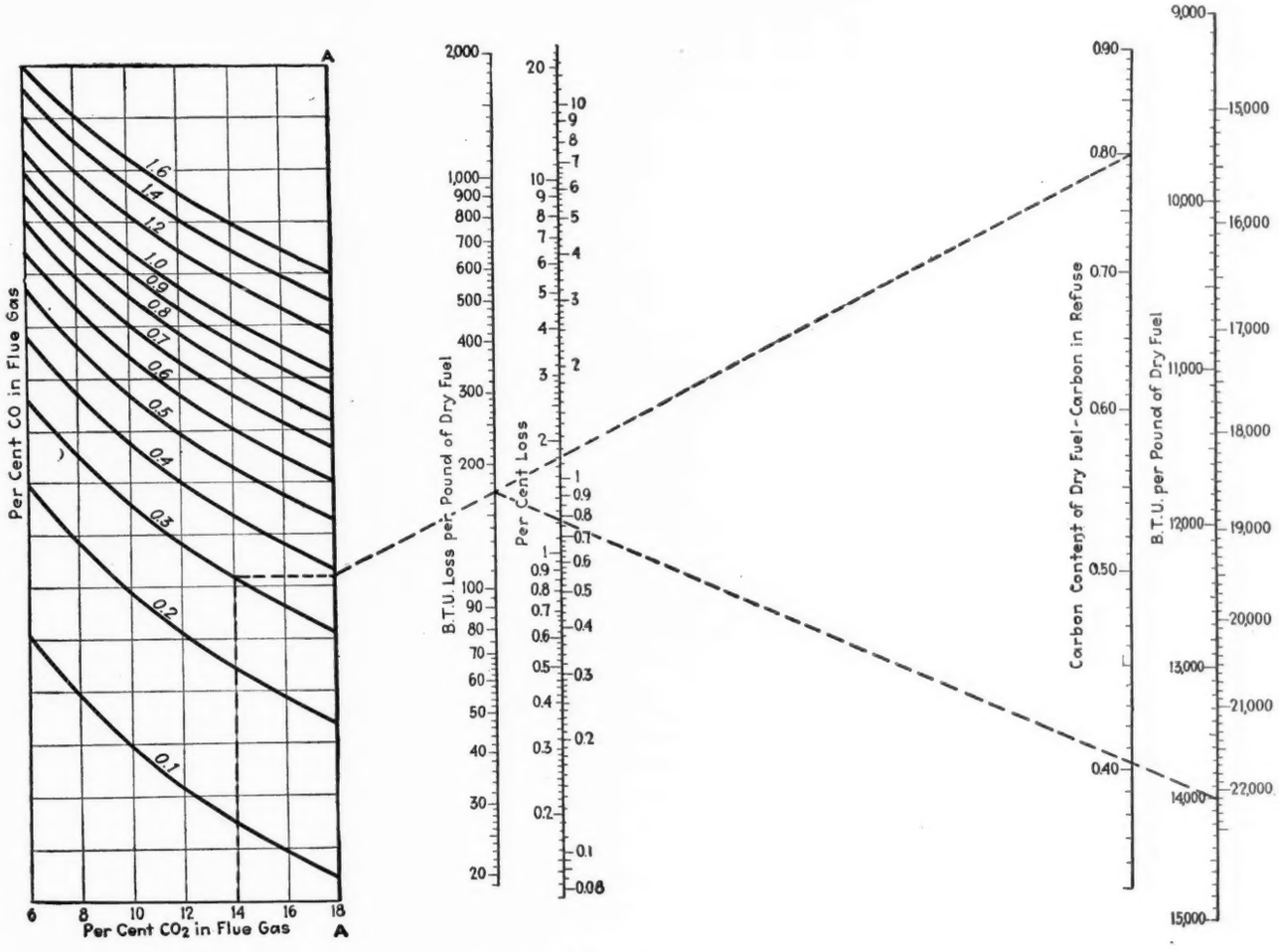
In using the chart, find, in the graph portion at the left hand section, the intersection of the vertical line corresponding to the observed value of CO_2 with the curve for the observed value of CO. Carry this across the graph to the right to its intercept with the heavy line *A-A* at the right-hand edge of the graph. Lay a straight-edge from this point to the value of the carbon content of dry fuel minus carbon lost in the refuse, and read the scale for B.t.u. loss per pound of dry fuel. To find the percentage loss, connect this point with the heating value of the dry fuel and read the per cent loss scale. If the values on the left side of the B.t.u. per pound of dry fuel scale are used, then the left-hand values on the scale for per cent loss should be read and the right side of the one with the right side of the other.

An example will illustrate how the chart facilitates heat-loss determinations due to incomplete combustion. Assume that coal of 14,000 B.t.u. heating value has been burned, producing in the flue gas 14 per cent of CO_2 and 0.3 per cent of CO. The coal analysis and the per cent carbon in the refuse show that 0.8 lb. of carbon per pound of coal was actually burned.

Enter the graph to the left of the chart at 14 per cent CO_2 and proceed vertically to the curve marked 0.3 per cent CO. Transfer the point of intersection horizontally to the reference line *A-A* at the right-hand edge of the chart.

With a straight-edge connect this point with 0.8 lb. of carbon on the scale marked "Carbon Content of Dry Fuel—Carbon in Refuse." The intersection of the straight-edge with the scale of heat loss gives a value of 170 B.t.u.

To find the per cent heat loss due to incomplete combustion, connect with a straight-edge the heat-loss value of 170 B.t.u., just found, with the point marked 14,000 B.t.u. on the left-hand side of the scale marked B.t.u. per pound of dry fuel, and, on the left-hand side of the per cent scale, the per cent loss is found to be 1.22.



Nomograph for heat loss due to incomplete combustion

This Machine Makes Ice Flakes

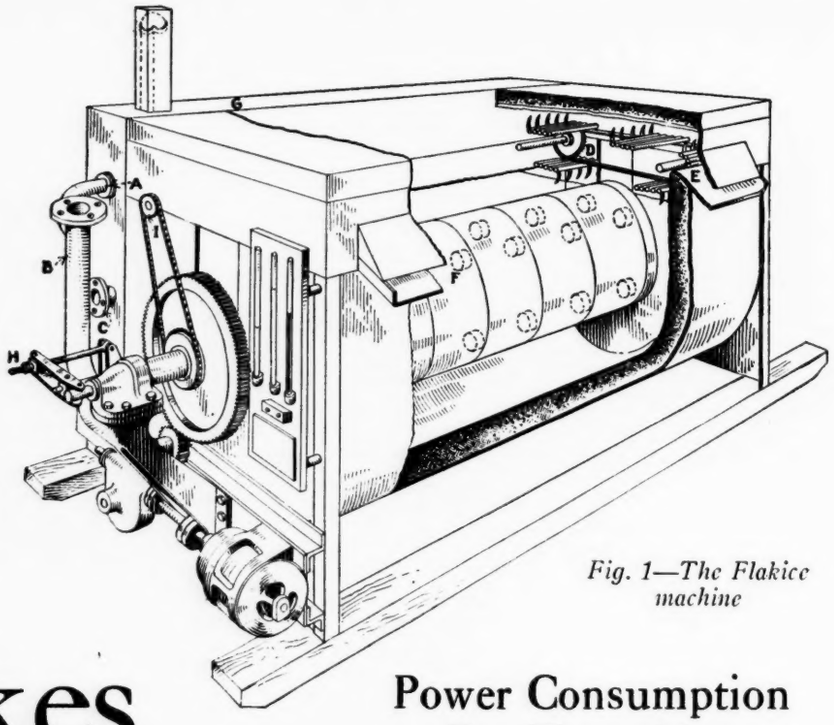


Fig. 1—The Flakice machine

Power Consumption Per Ton of Ice Is Reduced

A MACHINE has been developed to manufacture ice by a continuous process, the product being ice flakings suitable for general refrigerating purposes. In effect the machine consists of a refrigerated drum upon which water is deposited and frozen. The drum shell is then distorted, causing the ice to break off as flakes.

Originally, all ice was obtained from the natural freezing of ponds and lakes. This was sawed into convenient cakes for storage. When the manufacturing of artificial ice came into being, the natural freezing process was more or less followed, with the ice frozen in the form of large plates or sheets. These were then cut into suitable cakes.

The next step was the can plant of today. Here we have about fifteen cans for each ton output per 24 hours, the freezing time ranging from 30 to 50 hours. These cakes are withdrawn when frozen and finally cut or broken into sizes to meet the housewife's demands. Other cakes are broken up and used as bunker ice, and others are finely crushed for top dressing for vegetables in transit.

To one not grown accustomed to ice making, the process of making large cakes so that crushed ice can be obtained seems the height of engineering folly. In addition the freezing tank and storage calls for much room space and a high investment cost. Consequently, ice that costs for power, only 75 cents per ton, may have a total manufacturing cost of $4 per ton.

Long ago, refrigerating engineers, notably Holden, experimented with the idea of freezing ice by revolving a refrigerated drum in a tank of water. The ice was removed by a set of knives, but the disadvantages offset the decrease in room space. The knives exerted so much pressure against the drum that the power demand was high. The upkeep was also excessive, and the ice left the drum in a mushy condition. Attempts were made to squeeze out the water, but the product remained a poor substitute for can ice.

The problem was taken up a few years ago by the Flakice Corporation, and its president, Crosby Field, made an extensive study of continuous freezing methods that might insure a better product. With this research work has come the present Flakice machine, shown in Fig. 1.

The principle of this apparatus is the freezing of a thin layer of ice upon a metal surface and the removal of this ice in flakes by mechanically distorting the metal. The principle can be incorporated in machines using any of several types of freezing surfaces, such as a cylinder or a disk.

As shown in Fig. 1, the machine makes use of a drum partly submerged in the water to be frozen and inclosed in an insulated box. This drum is made up of a series of MOND 70 metal cylinders attached together to make a continuous drum, by special rubber ligaments.

A hollow shaft, driven through a gear box by a motor, carries the drum. Brine enters the hollow shaft by the pipe *B* and, issuing out of a set of nozzles, impinges on the inner wall of the drum. It flows back through the other end of the shaft into the surge tank *G* and out through the connection *C* to the brine cooler, which is a separate apparatus. Excessive brine pressure is avoided by the connection *A* between the inlet and the overflow pipe.

Inside the drum is a set of rollers *F* attached to a shaft passing through the hollow shaft. The operation is as follows: The brine is pumped through the

shell, which is revolved by the gear. The chilling of the cylinder causes the water touching the metal to form into a thin sheet of ice, and when this ice is of sufficient thickness the lever *H* is shifted to bring the rollers *F* against the drum shell. The latter is deformed by the pressure of the rollers; the ice then breaks loose, as at *B*, Fig. 2, and is gathered by the rod rollers *D*, which are drawn by the gear *I*. The conveyor rollers move the ice to the exit *E*. This ice is not mushy but can be termed "dry." The rollers are then withdrawn, and the freezing process is continued.

Freezing Under

If the rollers be maintained at their maximum deflection continuously, then there appears a new phenomenon, called "freezing-under." To understand this phenomenon it must be borne in mind that the thicker the ice cake the less the amount of deflection required to clean it off. As the ice first forms on the cleaned metal surface, it is quite elastic and will follow the contour of the curved surface under deflection without cracking or showing any signs of peeling. As it grows, however, it reaches a thickness which, although not enough to cause it to peel, is enough to maintain its original form and not follow the metal as it changes its shape while passing over the roller *A*. The result is a hollow space, as at *B*, *C* and *D*, Fig. 3, between the under surface of the ice and the metal, which extends for a short distance on either side of the point of tangency of the roller with the metal heat-transfer surface. Into this space water rushes and is quickly frozen to both the under surface of the ice cake and the cylinder. The ice cake thus formed is built of numerous laminations, all frozen together, but which, when broken, clearly show the marks of each individual layer. This building up continues until a total thickness is reached, when the ice peels, as at *E* and rises to the top in the same manner as by the "intermittent deflection" or "freezing-under" conditions.

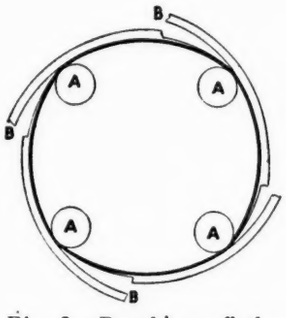


Fig. 2—Breaking off the flakes with intermittent freezing

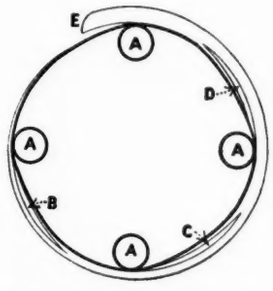


Fig. 3—Action when the shell is continuously distorted

For the thicker cakes the underflow method has great advantage in production rates. This advantage is lessened when the cake thickness is small. Machines intended for thin cakes are not designed for continuous operation under "freezing-under" conditions.

The third method of operation has for its primary object the production of clear ice. In this case the rollers are maintained in the position of maximum deflection, but the cylinder is stationary during the freezing period and is caused to peel its ice by rotating for a short period, at intervals.

The relation between these methods is shown in Fig. 3. It has been found that the output varies with the deflection of the cylinder and the speed of rotation. Any ice thickness can be produced by varying these factors, but the higher production will always be with underflow freezing.

In Fig. 4 are shown the tonnage outputs at various machine speeds and different deflections of the metal cylinder.

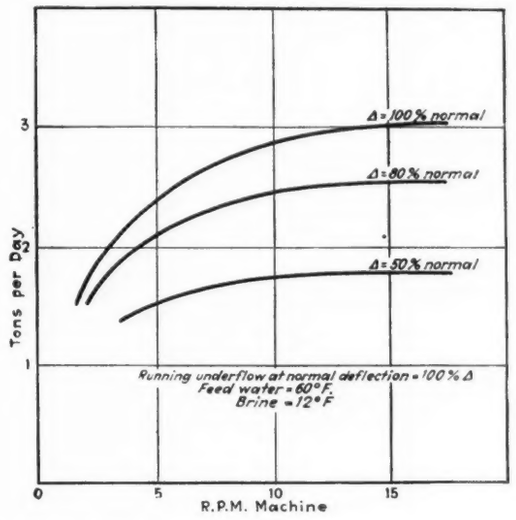


Fig. 4—Relation of tonnage and shell distortion

This freezing system has a wide field of application, especially where crushed ice is needed. However, cakes of any thickness can be frozen, although the freezing time increases with an increase in ice thickness, as will be seen from Fig. 5.

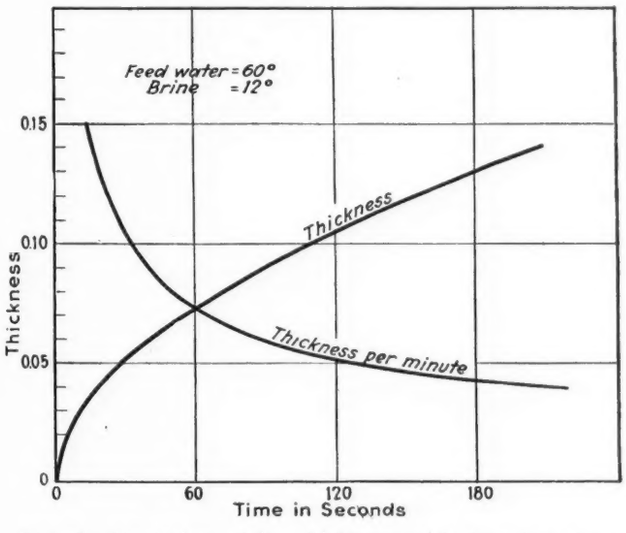


Fig. 5—Variation of ice thickness with freezing time

This article is based on an interview with Crosby Field and on a paper presented by him before the American Society of Refrigerating Engineers.

Correction—The welding photograph on page 436 of the March 12 number of *Power* was obtained through the courtesy of the Lincoln Electric Company. Credit was inadvertently omitted.

Exhaust from Two 1,300-Lb. Turbines Will Operate

Lakeside's New 60,000-Kw. Unit

This new machine with the two 1,300-lb. turbines will carry the station base load. Features of the big turbine are an impeller-type oil governor, new methods of reaction blade fastening and cylinder support, and facilities for guarding against spindle distortion.

THE new 60,000-kw. turbine-generator recently installed in the Lakeside Plant of the Milwaukee Electric Railway & Light Company takes its place among the largest single-cylinder complete-expansion turbines thus far constructed. It is the first of the size and type made by the Westinghouse Electric & Manufacturing Company. In its construction the principal features of interest are the use of an impeller-type oil governor in the place of the mechanical flyball type, the use of a new type of fastening in the last three rows of reaction blading, the single-anchor method of supporting the cylinder, and the provisions for insuring easy starting. Before going into these details, however, the general relation of this unit to the two-pressure steam design of the station will be of interest.

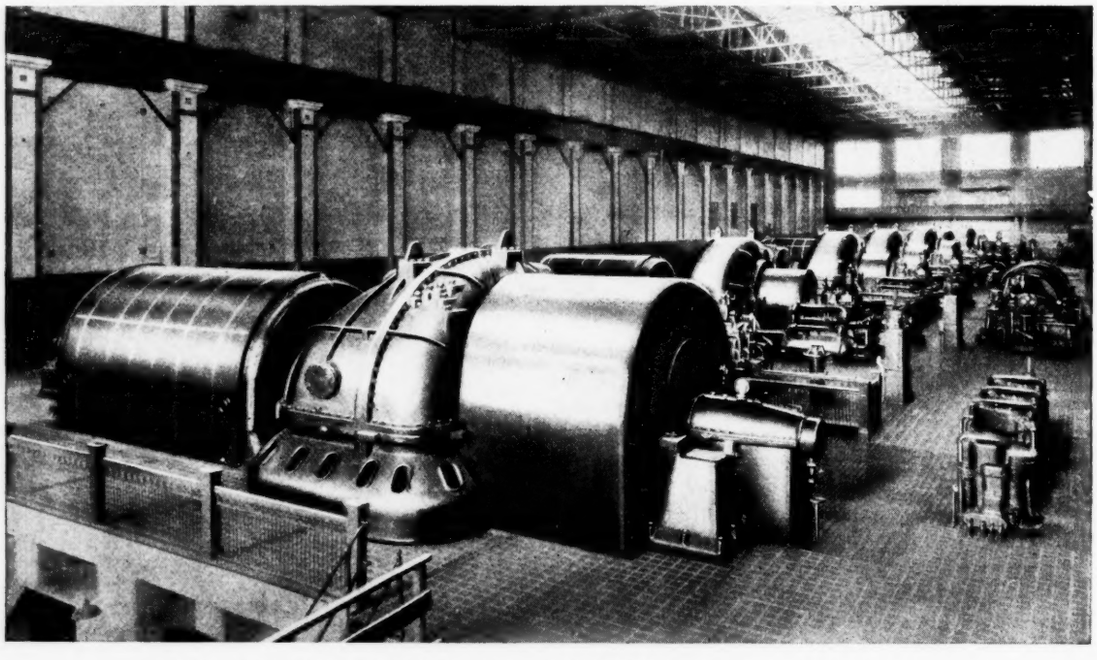


Fig. 1—Lakeside turbine room with 60,000-kw. unit in foreground

Including the new machine, Lakeside station now has an aggregate installed capacity of 234,700 kw. in nine units. Originally, two 20,000-kw. units were installed in 1920. Some time later, when it looked as if the art of turbine design would be stabilized at 30,000-kw. as the upper limit of size, the station plans were modified so that the increments of boiler and turbine capacity were in units of that rating. Four machines each of 30,000 kw. capacity have followed the initial installation.

When improvements in steam generating and turbine equipment made practicable the higher pressures now coming into general use, Lakeside was one of the first stations in the country to have a 1,300-lb. installation. The first unit of this character with its 7,000-kw. turbine generator installed in 1926, gave the station an extra steam capacity equivalent to 30,000 kw. Placing the new 60,000-kw. machine in service created a shortage in boiler capacity equal to the former excess, but this condition will be relieved during the present year by the addition of another 1,300-lb. boiler.

Future development of the station will be along the line of the higher steam pressure, as the economy of this course has been established by the operating experience

with the two high-pressure units, one rated at 7,000 kw. and the other at 7,700 kw. The latter turbine was installed last fall, but is not yet in continuous operation on account of the present deficiency in high-pressure steam. When the second high-pressure boiler is installed, either turbine may take steam from either boiler or each from its respective boiler and exhaust through reheaters into the 300-lb. station header supplying the other turbine-generators of the station.

As the new 1,300-lb. boiler will be identical with the one now in service—that is, of the Stirling type with an output of 250,000 lb. of steam per hour—it will permit the continuous operation of the two high-pressure turbines, which will exhaust steam to the 300-lb. system at the equivalent rate of 60,000 kw., the capacity of the new machine. This combination will give the station an operating unit consisting of two high-pressure and one lower-pressure turbine that will be highly efficient in carrying the base load.

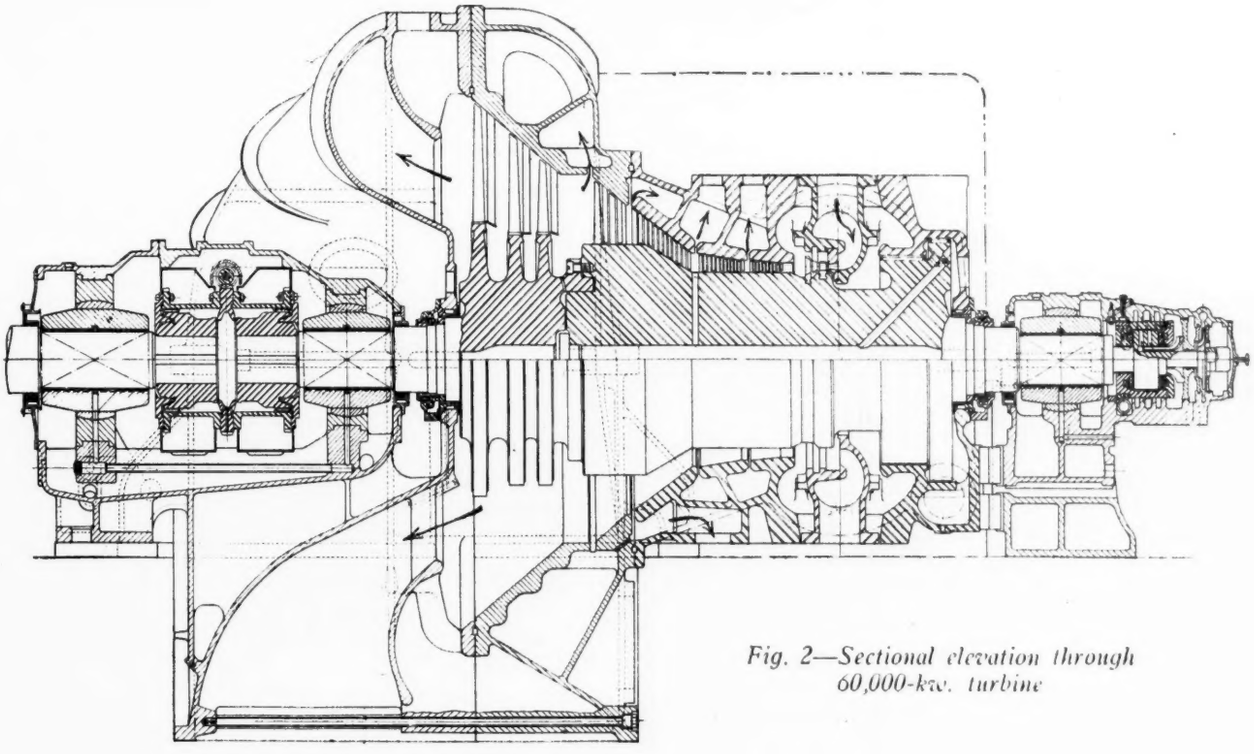


Fig. 2—Sectional elevation through 60,000-kw. turbine

Reference to Fig. 1, showing the new machine in the foreground, indicates that the general design follows the modern tendency in that it is particularly free from accessory devices. Even the governor-control mechanism has been removed from the machine to a pedestal shown at the right in the photograph. Physical dimensions, including an over-all length of 63 ft. for the unit, are given in the accompanying table, and the general design of the turbine is shown in the sectional elevation, Fig. 2. The generator is a three-phase 60 cycle machine having an output voltage of 13,800. As is customary, the exciter is mounted at the end of the shaft, and below the machine is a generator air cooler of the closed type. A 55,000-sq.ft. single-pass condenser with motor-driven auxiliaries serves the turbine. The initial gage pressure at the turbine throttle is 290 lb., the steam temperature 700 deg. and the speed of the unit 1,800 r.p.m.

Reference to the heat balance and flow diagram of steam and condensate, Fig. 3, indicates that at a load of 61,600 kw. the new machine produces a net kilowatt-hour on 11,510 B.t.u. Extraction takes place at the four points indicated, and the steam passes to each of four heaters. It will be seen that the condensate first passes through the generator air cooler, then through heaters Nos. 1 and 2, from which a portion of the feed is supplied to the 300-lb. system. The greater portion, however, is passed also through heaters Nos. 3 and 4 and then by boiler-feed pumps, operating against a head of 1,450 lb., is forced into the 1,300-lb. boilers. Condensate from the heaters is trapped back from one to the other in the reverse order of their numbers, and from No. 1 heater is finally taken by an extraction heater pump and forced back into the condensate line between heaters Nos. 1 and 2. Pressures, temperatures, quantities of steam and B.t.u. contents are all indicated on the diagram, as well as the paths taken by the extraction steam and the condensate.

It will be recalled that one of the interesting features of the new turbine is an impeller oil governor, which, as the name suggests, consists primarily of an impeller mounted on the turbine shaft and supplied with oil. The impeller produces an oil pressure proportional to the square of the r.p.m. This pressure is used to actuate a relay controlling the admission of high-pressure oil to an operating cylinder, the piston of which may operate the steam admission valves directly, or may in turn actuate separate relays and operating cylinders controlling the several admission valves. In this case the primary operating system actuates a camshaft controlling the movement of individual relays that operate the admission valves.

In connection with the oil impeller there is provided an oil ejector, located near the bottom of the oil reservoir and supplied with oil from the impeller discharge. This ejector draws oil from the reservoir and delivers it to the impeller suction chamber under a positive head of about five pounds gage, thus insuring stable operation of

the impeller. A second impeller, of the conventional centrifugal pump type, also mounted on the turbine shaft, supplies oil to the valve operating mechanism and to the turbine lubricating system. It is kept primed by another ejector.

The turbine rotor is composed of two forgings, the one forming the high-pressure and being of carbon steel and that forming the exhaust end of 3½ per cent nickel steel, because of the high blade load. The two pieces are joined by a long spigot fit, secured by means of a large number of bolts arranged with means for drawing them up to a predetermined and uniform stress, such that the frictional contact of the joint faces would be sufficient to hold the pieces against creeping even if there were no spigot fit.

The exhaust and spindle forging has been designed so that the last three rows of blades are carried in integral disks. Instead of consisting in each case of a single groove turned in the periphery of the disk, the blade grooves in these disks consist of a series of curved grooves or slots across the disk in an axial direction. Into these grooves, which are formed in the contour of a buttress thread, the blades are inserted from the side and the choice of centers of curvature of the blade-root surfaces is such that each blade inserted locks the one ahead of it against withdrawal. Projections on the ends of the blade roots are afterward rolled over into grooves in the sides of the disks. This fastening is stated to be the most efficient available at the present time, and in addition it makes possible a considerable reduction in the over-all length of the rotor.

In accordance with methods developed from previous experience the turbine cylinder is anchored at only one point. It is restrained against displacement of the center line relative to the generator center line, but is free to expand in all directions from the anchor, which is under the coupling and pedestal. The exhaust end of the turbine cylinder is carried by a supporting flange that rests on heavy sole plates grouted to the foundation and machined in place. The thrust end rests on pads on the thrust-end pedestal, which is bolted to the foundation and carries the thrust bearing housing. The latter is connected to the cylinder by comparatively flexible struts, and keys, restrained between guides on the thrust housing and pedestal, prevent lateral displacement of the thrust end pedestal.

To avoid spindle distortion, to which all turbines are subject during the cooling process after shutting down, two means are provided for rotating the spindle. In addition, compressed-air connections to the cylinder are provided so that the vapors within the cylinder structure may be circulated and in this way uniformity of temperature of the medium surrounding the spindle is maintained.

The rotating devices comprise a turning gear capable of keeping the spindle rotating at about 25 r.p.m., and a hydraulic jacking gear that may be used to move the rotor half a turn at stated intervals. The rotating gear may be engaged before the spindle comes to rest. By the judicious use of this combination of facilities it will be seen that good starting characteristics are assured at all times.

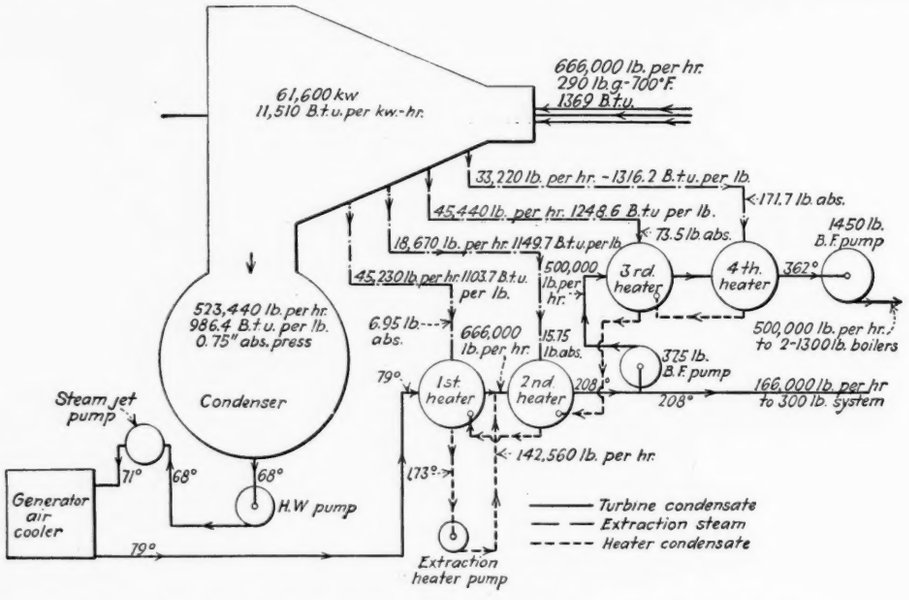


Fig. 3—Heat balance and flow diagram of steam and condensate

PHYSICAL DATA ON NEW UNIT AND AUXILIARIES

Turbine-generator	Westinghouse Electric & Mfg. Co.
Rating at 0.85 power factor, kw	60,000
Steam pressure at throttle, lb. gage	290
Steam temperature, deg. F	700
Speed, r.p.m.	1,800
Impulse blading, stages	2
Reaction blading, stages	22
Generator, 3-phase, 60-cycle, 13,800-volt, kw	60,000
Exciter, direct connected, 250-volt, kw	175
Air cooler surface, sq.ft.	15,080
Length of unit, over-all	63 ft. ½ in.
Width of turbine	21 ft. 10 in.
Width of generator	13 ft. 8 in.
Height of turbine, from floor	12 ft. 11 in.
Height of generator from floor	11 ft. 2⅝ in.
Distance, center to center, turbine bearings	17 ft. 8 in.
Distance, center to center, generator bearings	25 ft. 11 in.
Diameter of turbine shaft, in.	14
Diameter of generator shaft, in.	16
Weight of turbine rotor, tons	59
Weight of generator rotor, tons	73
Weight of turbine generator, tons	466
Diameter of largest wheel	12 ft. 2 in.
Peripheral speed of largest wheel, ft. per sec	1,142

Condenser and Auxiliaries

Maker	Foster-Wheeler Corp.
Condenser, single-pass, 9,240 tubes ¾ in. dia., 26 ft. long; area condensing surface, sq.ft.	55,000
Circulating pumps, two, g.p.m. each	52,500
Drive, motor, hp.	400
Condensate pumps, two, g.p.m. each	1,400
Drive, motor, hp.	100
Air pumps, c.f.m. at 0.67 in. abs.	15
Extraction heaters, four, sq.ft.	No. 1—2,700; No. 2—2,500; No. 3—2,900; No. 4—2,650
Extraction heater pump, one, 4 in., g.p.m.	370

Right Out of the Plant

Condenser Pressures and Temperatures

IN THE Feb. 26 number of *Power,* on page 366, in answer to a question of W.A.G., the statement is made that a thermometer does not give a temperature reading corresponding to the absolute pressure as given in steam tables. While this seems to be right from a theoretical point of view, it is used as the final check on corrected mercury column readings by at least three condenser manufacturers. In running tests on condensers in actual operation, where there is a chance to measure the temperature of the non-condensable gases before they have been cooled, they have been heated to a point so close to the vapor tension temperature, that the difference was not readable on twelve-inch laboratory thermometers. And I find among condenser maintenance men that when the thermometer placed in the intake to the condenser does not correspond to the mercury column reading, they recheck the mercury column to make it correspond.

M. C. CROSSETT, Supt. of Power,
Granite City, Ill. Commonwealth Steel Company.

[True, in the majority of plants, especially new ones, the condensation temperature and pressure will agree, but an operator is ill-advised if he blindly assumes that in the condenser in his charge the two do agree. He may ultimately discover that the condenser is so filled with air as to raise the actual pressure materially.—Editor.]

Isolation and Insulation of Auxiliaries in the Power Plant

WITHIN recent years the matters of vibration and soundproofing have entered the domain of power. High rotative speeds are partly responsible, as they introduce noise and unbalance. The twin problems of insulation and isolation are handled satisfactorily in hundreds of cases by mats of a somewhat resilient material placed between machine and floor. The materials used are cork in pulverized or sheet form and balsa wood. By the cushioning effect of these mats, vibration and sound are absorbed and practically eliminated.

The application of resilient mats is a wide one throughout industry, but in the realm of power appliances may be mentioned pumps, compressors, small engines, fans, blowers, motors, elevator machinery, frequency changers, receivers and tanks. Included in this list are machines of the pulsating type and those of high speed, as well as machines with automatic control and frequent starts. Such equipment is likely to be noisy, give trouble in keeping bolted fast, and set up unpleasant vibrations in the building. Intelligent use of a pad under a machine in one of these classes is sure to bring a measure of relief.

A machine must be carefully leveled up when placed on such a pad, just as when on the floor. Correctly done, it is often possible to dispense with fastening bolts —but this is a matter to be determined in individual cases. On the top of the pad, a sheet of steel is placed. This protects the soft material from abrasion, distributes the load and affords better means of leveling. The cork pads come made up of pulverized cork put together with a binder and in strips of natural cork approximately two inches thick, bound with a steel frame.

Balsa, previously mentioned, is the lightest wood known. It is from a tropical tree that attains a height of 30 ft. in three years, cell walls are thin and large, barrel-shaped, confining considerable dead air, which actually makes up 92 per cent of the total volume. Furthermore, balsa is the only insulating material in general use that can support itself and, in addition, a considerable part of the weight and stresses of a structure in which it is used. In the refrigeration field tanks of this wood are used in place of those having two walls and a space filled with fiber, wool or cork.

For power-plant auxiliaries balsa may be obtained in panel form 24 in. wide and in lengths up to 10 ft. Joints of structures are made by dovetailing and the use of hardware. When employed in mat form under a machine base, the use of a sheet of steel is advisable unless the base has a much broader bearing than usual.

Contrary to general impression, our modern buildings are not as immune from vibration and noise as might be imagined. To deaden noises, there should be a break in the continuity of floor materials and a padding between steel beams and a floor laid on them. Noise travels ten times as fast through brick as through air, and reverberations prolong noise. Not being able to change the structure of the building which houses it, auxiliary equipment must be silenced and quieted by the men in charge by the use of local means or proper materials.

Middletown, N. Y. DONALD A. HAMPSON.

Flywheel Might Have Carried the Peak Loads

I HAVE read with interest the article entitled "Graphic Instruments," by R. S. Wertheimer and W. D. Riggs, in the Feb. 19 number. From my understanding of this article I believe common remedies of motor trouble have been overlooked by the authors. For example, they show that a certain motor on a chipper had to carry 230 per cent load at intervals, and that this load was caused by large blocks in the chipper. They also state that the average horsepower demanded by a 75-hp. motor was 76 hp. Rather than install a large motor, it may be that a flywheel of sufficient size to carry the motor over the peak load would be a better solution.

As part of the explanation of the burnout of the digester pump motor, it is stated that the overload on this motor was sustained because the operator failed to shut it down. It would seem to me that the trouble here was caused by lack of adequate protection of the motor either by fuses or an automatic circuit breaker, which would have eliminated the human element. Just how this overload was sustained was not made clear.

Generally speaking, I believe that it is considered best practice to keep all motors loaded as near their full rated capacity as possible, and when peak loads are unavoidable, the motor can be helped to carry these by the installation of a flywheel of proper size.

Chicago, Ill. S. E. NICHOLS, Electrical Engineer,
Van Schaack Bros. Chemical Works, Inc.

Psychology in the Engine Room

THERE is a little-known law of psychology that has a valuable application in a power plant. It consists of having the subconscious mind give warning of approaching danger to the machinery that is in motion. It is done by first concentrating the conscious mind on the entire plant and then gradually passing the job over to the subconscious mind. For instance, when taking a walk, we first direct the various muscles necessary for walking, with the conscious mind, and then we think of other things and the subconscious mind assumes these duties without any further efforts on our part. Or when we wish to arise at an earlier hour than usual, we tell our subconscious mind to awaken us at that hour, and it usually does.

This method can be followed by anyone who does not dissipate and has the power of concentration to build up enough thought power. While this is not an easy thing to do, the results will be so surprising and valuable you will feel amply repaid for the efforts made. I have tried this method for four years while in charge of a power plant, with a success that at times seemed unbelievable. For instance, while in other parts of the building I would be moved by an invisible power, to go to a particular bearing and find that the oil had stopped flowing and the danger point had been reached.

In these days of modern progress such as automatic substations and hydraulic plants, why burden the conscious mind with that which can be better done by the subconscious mind? This subject, so far as I know, has never appeared in print, nevertheless, it is capable of demonstration and worthy of consideration.

St. Louis, Mo. H. C. JOHNSON.

Flooding a Barometric Condenser

IN THE Feb. 12 and March 5 numbers reference is made to the draining of an exhaust pipe between an engine or a turbine and a barometric condenser, where there is a horizontal section below both the turbine and the condenser.

Unless this horizontal portion is properly drained, there is likely to be an accident sooner or later. There are vacuum traps that will perform this service when they are in perfect working order, but there is seldom any indication that the trap is not performing its function until something unusual and disastrous occurs.

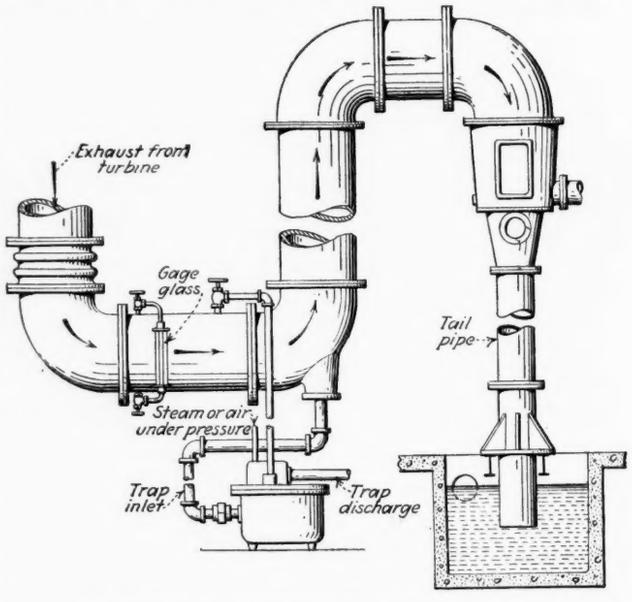
In my opinion there is but one safe method and that is to install a receiver of considerable capacity below the lowest point in the exhaust line and to drain the latter to the receiver through a fairly large pipe. Condensation will collect in the receiver and can be automatically removed with a hotwell pump in much the same manner that a surface condenser is drained, and a simple tell-tale can be attached to indicate continuously that the hotwell pump is operating as it should.

Providence, R. I. WARREN B. LEWIS.

THERE are reliable vacuum traps manufactured that do this work satisfactorily. I have been using one on a barometric condenser installation for two years without a single interruption due to any fault of the trap. The contention of some engineers that the velocity of flow will sweep the condensation that accumulates at the lowest point of the exhaust line, into the condenser does not hold true in all cases, owing to varying pipe sizes and bends holding a greater or less amount of condensate.

To check this theory, I connected a gage glass at the lowest point of the exhaust line and placed the turbine and barometric condenser into operation under varying loads. I found under all load conditions that the water level kept rising steadily, so concluded that safe operation warranted an automatic means of removing the condensate from the pipe.

The piping and trap installation should be about as shown in the illustration, the pipe connecting the exhaust



How trap is connected to the exhaust line

line with the trap inlet should be of liberal area, and the trap should be not less than 32 in. below the bottom of the exhaust line. E. A. BAERER.

Bayonne, N. J.

Why the Air-Compressor Belt Flapped

A CERTAIN railway company experienced trouble with the belt connecting an air blower to the driving pulley of a single-cylinder Diesel engine in one of its pumping stations. The belt seemed to pass through regular cycles of flapping and then running smoothly. For a few seconds it would run as smoothly as could be expected; then it would wave and flap in an annoying manner. The alignment of the two pulleys was checked and found to be correct. Still the belt would not run smoothly. Finally one of the company engineers solved the problem.

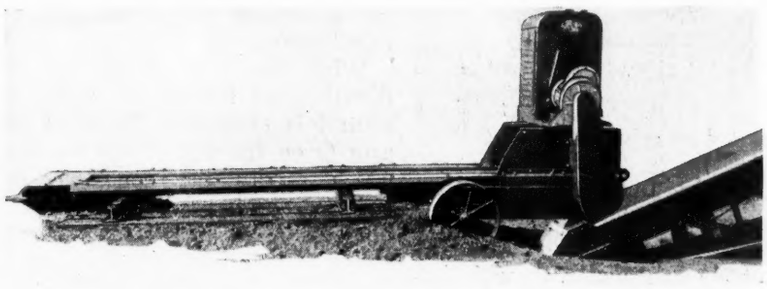
The compressor and engine were designed to run at the same speed. They had been belted together by two pulleys of the same size in order to give this relation of speed. Of course there was some slip in the belt. Since both machines were single-cylinder, every little while the slip in the belt would allow the piston of the compressor and the Diesel piston to get into such relative positions as to cause alternate load and no load on the belt connecting them, hence the periodic flapping.

This difficulty was quickly corrected by changing the pulley on the engine shaft for one of a little smaller diameter. This caused the compressor to run a little slower, but as its full capacity was not needed, it worked satisfactorily. This arrangement did not permit the pistons to stay in any relative position long enough to cause the belt to flap. R. F. SORRELLS.

Orange, Tex.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Unloader shown in position over the rail

Portable Belt Unloader for Hopper-Bottom Cars

FOR unloading cars of all bulk material, the Barber-Greene Company, Aurora, Ill., announces a new belt feeder. It will handle such materials as coke, coal, cinders and any other free-flowing material usually transported in hopper-bottom cars.

The machine eliminates the necessity for constructing a large pit under the railroad tracks. A small pit on the outside of the railroad track to permit the conveyor hopper to sit under the discharge end of the feeder is all that is needed.

It is claimed that the feeder will speed up unloading, will control the flow of the material within the capacity of the conveyor and will protect the conveyor and especially the belt from overloading and damage. The machine may be used either over the rail or under the rail, as required. The maximum thickness through the feeder frame, including the top sliding plate, is $4\frac{1}{16}$ in. Either an electric motor or a gasoline engine can be used to drive the feeder.

Self-Locking Bolt and Nut

A NEW form of screw-thread, which gives a locking action between the bolt and nut and eliminates the use of locknuts, lock washers and cotter pins, is illustrated. The thread angle approximates that of the Acme with the difference that the space *A* is considerably wider than the thread and the bottom of the thread *B* is at an angle with its axis, the high side, or large diameter, being toward the end of the bolt. When the nut is screwed on the bolt, the action is as follows:

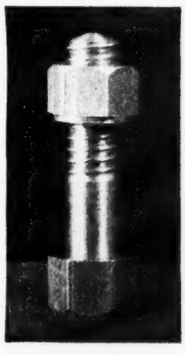


Fig. 1—"Threadlock" bolt and nut

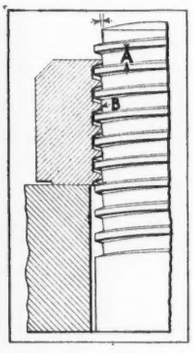


Fig. 2—Detail of thread

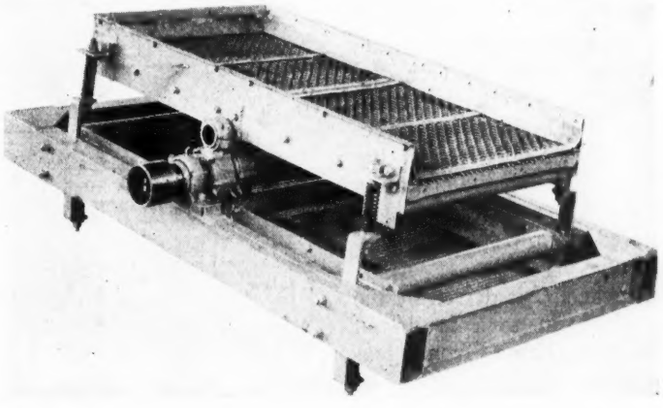
The nut advances along the bolt with the conical surfaces lightly in contact. When the nut seats on the work, the conical surfaces are forced into closer contact and the material of the nut is stressed within its elastic limit until the side or abutment faces of the threads are in contact. The nut is then under stress and is locked to the bolt by the friction of the inclined surfaces at *B*. The locking action so produced is effective at any point along the threaded length of the bolt. The nut can, however, be readily released with a wrench and can be used repeatedly.

This new form of thread, which is known as the "Threadlock," is being introduced by the Dardelet Threadlock Corporation, 120 Broadway, New York City.

Balanced Vibrating Screen

A DEPARTURE in vibrating screens appears in the Telsmith anced Vibrator brought out by the Smith Engineering Works, Milwaukee, Wis. As shown in the illustration, two screen decks are caused to vibrate simultaneously and in opposite directions through opposed eccentrics running in ball bearings and mounted on a heavy shaft between the two screens. Both ends of each deck are supported by compression springs.

The feature of opposed motion of the two screening surfaces is said to result in greatly decreased vibration transmitted to the frame and driving mechanism. At the same time a vigorous and uniform vibration of both screen surfaces is maintained. Screen cloth is furnished in standard renewable trays, which are readily replaceable.



Screens are vibrated by opposed ball-bearing eccentrics

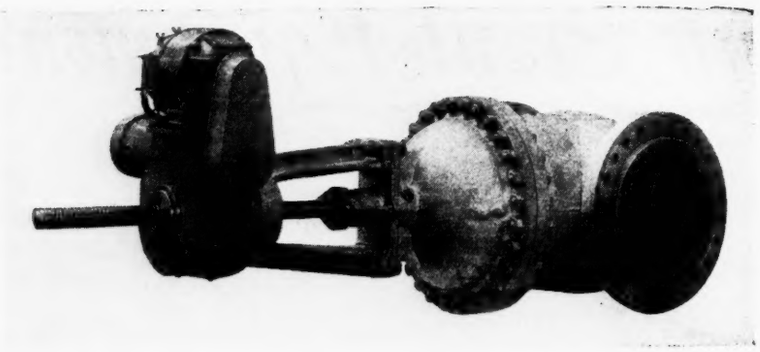


Fig. 1—Limitorque operator mounted on valve yoke

New Valve Operator Limits Torque on Valve Stem

A NEW departure in valve operators is the "Limitorque," brought out by the Limitorque Corporation, 17 East 45th St., New York City, and designed by Payne Dean. The unit embodies a number of important features, such as minimum number of parts (only one pair of gears), adaptability to either electric or air motor operation and use of a torque switch which stops the motor when the valve is properly seated or when a predetermined torque has been exerted on the valve stem. Fig. 1 shows the unit mounted on a valve; Fig. 2, an assembly of the operating parts; Fig. 3, a cross-section showing constructional details of the complete mechanism.

Referring to Fig. 3, the unit bolts directly to the flange on the top of the yoke in place of the standard yoke cap, the casing constituting that part necessary to hold the operating nut in place. A special operating nut *A* fitted with a ball bearing at each end, has keyed to it a collar *B*, and directly above it the wormwheel *C* is mounted and free to turn on the operating nut. A lug *D* on the collar contacts with a lug *E* on the wormwheel and effects the drive. The wormwheel (see Fig. 2), makes practically a complete revolution when starting in either direction before contacting with the lug on the collar or starting the operating nut; thus a positive unseating blow is administered at slow speed directly to the stem nut *A*.

The wormwheel *C* is driven by the worm *F*, which in turn is driven through the silent chain *G* from a motor mounted on the housing. The idea behind the use of a silent chain for the initial step in the drive is to allow other than standard motors to be used and to permit changing readily the speed ratio between motor and wormshaft.

Control of the motor, through limiting the torque exerted on the valve spindle, is accomplished in a rather ingenious way. The worm *F* is keyed to the shaft *H*, which has a squared end *J* free to float endwise in the

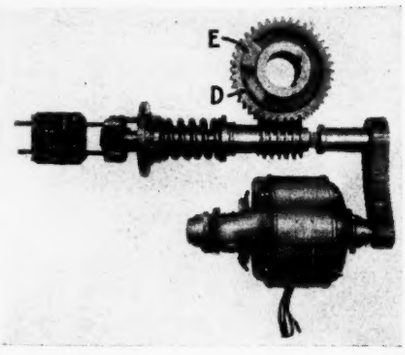


Fig. 2—Assembly of all operating parts

square bored bushing *K* to which the chain sprocket *L* is keyed. When the valve seats and the worm gear *C* stops, the worm tends to wind out of the gear toward the left, and this causes the shaft *H* to travel endwise, compressing the spring *M* and moving the switch *N* out of contact. Thus it will be seen that, before the motor stops, a predetermined torque is exerted on the valve spindle, while at the same time a torque sufficient to damage the valve cannot be produced. For if the gate should stop before seating, owing to any obstruction, the spring simply compresses and the switch is opened.

When operating in the opposite direction, or toward the right, the control is essentially the same—the arm *O* on the end of the shaft *H*, which carries the double contact switches, also has three equally spaced plungers *P* which press against the spring *M* and thus compress it, limiting the torque as before. The thrust, when moving in this direction, is taken by the ball bearing *R*. The amount of torque exerted, or the point at which the motor circuit is opened, is controlled by adjusting the position of the switch bars *S* in the arm *O*.

It will be apparent from the foregoing that the switch that controls the motor circuit is not geared in any way and bears no relation to the travel of the gate. It functions only when the gate is fully closed, or open, or overloaded.

For operating the unit by hand, a handwheel having a short square shaft that fits inside the bushing *K*, is provided. The handwheel is not permanently attached, but is chained to the valve yoke when not in use.

The "Limitorque" machine is adaptable to standard designs of valves with little alteration and may be adapted to existing valves already installed, without in any way disturbing the line. It is also used for operating window sash, rolling, sliding and bulkhead doors.

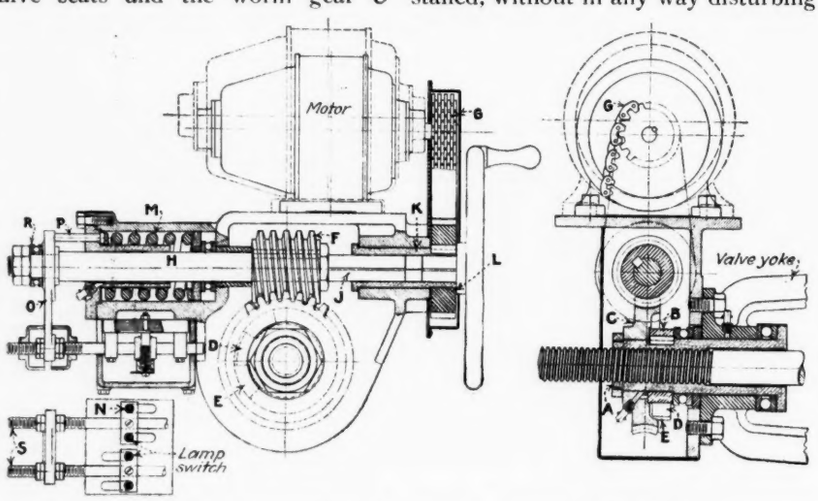


Fig. 3—Cross-section showing constructional details

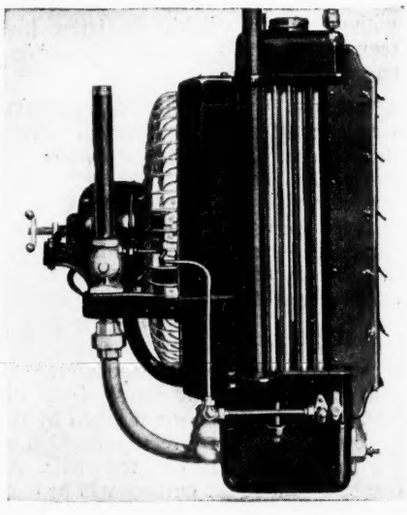
The motors are of standard Westinghouse design, slow-speed, totally inclosed and provided with ball bearings, all arranged for any standard electrical circuit to 550 volts. The motor is controlled in the usual manner by totally inclosed reversing switches with indicating lights.

Gas-Fired Unit Heater

A NEW gas-fired unit heater, known as the "Humphrey Industrial Unit," is announced by the General Gas Light Company, of Kalamazoo, Mich. The heater has a capacity approximately equivalent to 400 sq.ft. of ordinary steam radiation and is equipped with a fan delivering 1,800 cu.ft. of heated air per minute.

The heating element consists of a bank of special Ni-Chrome gas burners above which is a battery of brass-tube radiators so arranged that heat from the burner is equally distributed up through the tubes, while the combustion products are carried away by a perforated cap flue or by a ceiling flue if desired. A fan, driven by a $\frac{1}{6}$-hp. motor is mounted behind the tubes. The fan not only drives air across the heated tubes, but supplies combustion air under pressure to the burner box.

Heat control is maintained by a thermostat and the motor is in turn equipped with a governor which turns

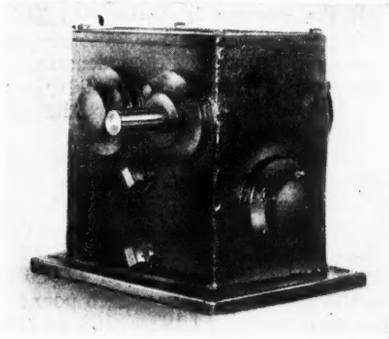


Side view of Humphrey industrial heater

the gas on and off as required to maintain an even temperature. Pilot lights on either side of the burner control a simple thermostatic switch that automatically prevents the motor from operating in case the pilots are extinguished.

Large Ratio Speed Reducer

SPEED reduction ratios from 100 to 1 up to 2,500 to 1 are obtainable in the No. 4D speed reducer illustrated. The mechanism consists of a double worm-gear drive having the



"W. H. S." No. 4D speed reducer

driven and driving shafts parallel. It is particularly suitable for light conveyor, coal feeder and similar drives where a large reduction is required.

Ball thrust bearings are fitted at each end of the two wormshafts. The material used for the gears is a high-grade gear bronze, and the worms are of steel, hardened and polished. Dimensions are $7\frac{7}{8}$ in. high, $7\frac{1}{2}$ in. wide, and approximately 11 in. from end of driven shaft to end of driving shaft. The reducer is put out by Winifred H. Smith, Inc., Springville, N. Y.

A-C Motor Starter Has Thermal Timing Device

A RECENT product of the Monitor Controller Company, Baltimore, Md., is a thermal timing relay

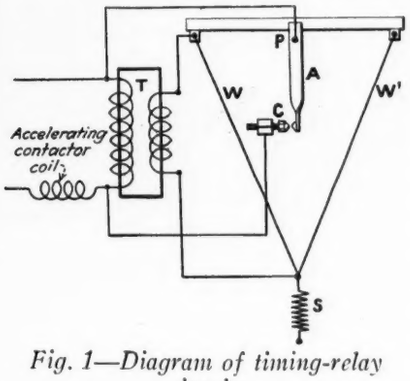


Fig. 1—Diagram of timing-relay circuits

for use with its automatic starters, using one step of primary resistance for starting squirrel-cage motors. The thermal relay controls the accelerating contactor's operation. The time period of this relay can be adjusted over a wide range and when set, the adjustment remains constant.

The principle of the relay is shown in Fig. 1. A walking beam is pivoted at P and carries an arm A, which is at right angles to the beam. Keeping the walking beam in position are two wires W and W^1, held taut by a spring S. Changes in room temperature affect both wires alike, therefore do not change the position of the arm A. One of the wires W has its ends connected to the secondary of a potential transformer T. The primary of this transformer is connected in series with the coil of the accelerating contactor, as shown in the figure.

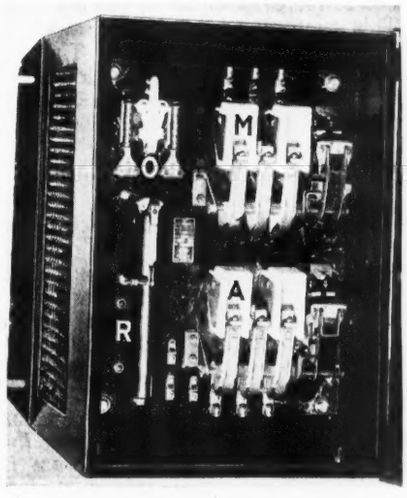


Fig. 2—Thermal timing-relay located at R

The relay contacts C are connected to the primary of the transformer.

A starter with one of the timing relays R is shown in Fig. 2. With push-button starting, pressing the start button connects the coil of the main-line contactor M across the line. When this contactor closes it connects the primary of the motor to the line through a resistance. This contactor provides a holding circuit for its coil so that it will stay closed when the push button is released. Closing of contactor M also connects the timing-relay transformer in series with the coil of accelerating contactor A and starts heating one leg of the relay. After a definite interval the relay R closes its contact, short circuits its transformer and impresses full voltage on the accelerating-contactor coil, which then closes its contactor. When this contactor closes, it applies full voltage to the motor terminals and cuts both the timing relay and its transformer out of circuit.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Wet-Bulb Temperature Is Not the Dew Point.—*Can I find the saturation temperature corresponding to the water vapor pressure in air by obtaining the wet-bulb temperature?*

G. R. S.

The wet-bulb temperature is not the saturation temperature, or, as it is sometimes called, the "dew point." The wet-bulb temperature is the temperature to which the evaporation of water from a wet cloth or wicking cools the mercury bulb. There is a heat interchange whereby the wet-bulb temperature first drops and then becomes fixed when the rate of heat absorption by convection from the air equals the rate of cooling due to the evaporation of the moisture. This temperature may be as much as 20 deg. above the dew point. The dew point can be found from a psychrometric chart if the wet- and dry-bulb temperatures are known.

The Economic Vacuum to Carry.—*In our plant we have a 500-kw. uniflow steam engine which now operates non-condensing but which we wish to run condensing. Water in our building costs one dollar per thousand cubic feet and we cannot install a cooling tower, so the water goes to waste. With a 27-in. vacuum we plan to have a 10-deg. temperature rise in the water. What would be the saving if we ran with 24-in. vacuum to reduce the amount of cooling water? Steam is purchased at an average rate of 80 cents per thousand pounds, the pressure being 125 lb. gage.*

B. R. T.

You do not state the steam rate of the engine at either 27-in. or 24-in. vacuum, and a rate of 14 lb. per i.hp.-hr. is assumed, with a boiler pressure of 125 lb. gage and with a 27-in. vacuum. This corresponds to a Rankine efficiency of approximately 62.5 per cent. With a mechanical efficiency of 90 per cent and a generator efficiency of 92 per cent, the rate per kilowatt-hour would be $\frac{14}{0.746 \times 0.90 \times 0.92} = 22.7$ lb. At a 500-kw. rating the unit would require $22.7 \times 500 = 11{,}350$ lb., costing $9.08. Each pound of steam has taken out of it $\frac{2{,}546}{14} = 182$ B.t.u. in the generation of power in the engine. Measuring from the condensate temperature of 114 deg. F., corresponding to 27 vacuum, there is in each pound of 125-lb. steam, 1,110 B.t.u. The generation of power takes out 182, leaving 928 B.t.u. to be removed by the condenser, or a total of $928 \times 11{,}350 = 10{,}530{,}000$. If the water is to have a rise of 10 deg., 1,053,000 lb. of water must be used per hour, and as a cubic foot weighs 62.2 lb. at 80 deg. F., there will be used 16,920 cu.ft., which would cost $16.92 per hour.

If the vacuum is dropped to 24-in., giving approximately 3 lb. absolute pressure and 140 deg. F. condensate, the water could have an additional rise of 140-114 = 26 deg., making the total water rise 36 deg. F.

With the same engine Rankine efficiency of 62.5 per cent, the engine would take approximately 16 lb. per hp.-hr., or approximately one-seventh more than with 27-in. vacuum; this would make the total steam consumption 12,960 lb. Measuring from 140 deg. each pound of live steam contains 1,192 — 108 = 1,084 B.t.u. As before, a horsepower-hour is equivalent to 2,546 B.t.u., and out of each of the sixteen pounds fed per horsepower 2,546 ÷ 16 = 159 B.t.u. disappears, leaving 1,084 — 159 = 925 B.t.u. per pound of steam to be removed in the condenser. For the total steam feed of 12,960 lb., the heat to be removed will be 11,990,000 B.t.u. As the cooling water is to take up 36 B.t.u. per pound, the total cooling water is 333,000 lb., or 5,350 cu.ft., costing $5.36 per hour.

We have then:

With 27-in. vacuum	
Cooling water	$16.92
11,350 lb. steam at 80c.	9.08
Total	$26.00
With 24-in. vacuum	
Cooling water	$5.36
12,960 lb. steam at 80c.	10.38
Total	$15.74

It is cheaper, then, to drop the vacuum to 24-in., but it would surely pay to install a spray pond on the roof and use a high-pressure condenser in the engine room; the pumping would consist of the friction losses in the piping and spray heads.

Operating with lower vacuum is the cheaper even though the steam costs more, if a spray pond cannot be used.

Drier Steam from Wiredrawing.—*How does steam become drier or superheated in the process of wiredrawing?*

G. D. M.

In its passage through a reducing valve or other form of opening, steam neither loses nor gains heat. The heat that is converted into work required for overcoming friction and inertia is restored to the steam. Hence, ordinarily, after expanding to a reduced pressure, each pound of the steam contains more heat than necessary for the same percentage of dryness that it had at the initial pressure.

For example, a pound of dry steam at 100 lb. gage pressure contains 1,188 B.t.u. while at 30 lb. gage it contains only 1,171 B.t.u. if dry saturated, and it will be superheated 30 deg. if there are 1,188 B.t.u. in it. That is, the process of wiredrawing, whether performed by passing the steam through a throttled valve, a pressure-reducing valve or other form of aperture, converts wet steam into a drier steam at the lower pressure, dry steam to steam that is superheated for the lower pressure, or may convert superheated steam to steam at a lower pressure with more degrees of superheating for the lower pressure than it had for the initial pressure.

Brush Wear.—*What causes side wear on carbon brushes of direct-current motors and generators?*

R. O. J.

This trouble may be due to either electrical or mechanical causes or a combination of both. Brushes without shunts, held in box-type holders, may develop side wear due to the flow of current from the brush to the holders. This may be particularly noticeable on heavily loaded motors that have commutators out of round. The eccentricity of the commutator causes the brushes to move up and down in their holders. This movement causes arcing between the brushes and holders which may wear the side quite rapidly. Where abrasive dust is present, a rough commutator may cause rapid side wear on the brushes. The dust works in between the brushes and the inside of the holders, and the uneven surface of the commutator causes the brushes to move on the dust and may produce a rapid wearing action. This action can occur with brushes equipped with shunts, but the wear will be materially accelerated on brushes without shunts. With the latter high temperatures will generally be experienced.

Starting Current of a Squirrel-Cage Motor.—*A 440-volt 25-hp. three-phase squirrel-cage motor is started on reduced voltage by a compensator. When the statement is made that the motor takes 2½ times full-load current at starting, does this refer to the line current or to the current between the compensator and the motor?*

R. B.

If this motor has full-voltage applied at starting, it will take about 600 per cent full-load current inrush from the line. The starting current taken by the motor will vary in direct proportion to the voltage applied to its terminals. At one-half voltage the current will be one-half that at full voltage. The line current varies as the square of the voltage applied to the motor terminals. At 65 per cent line voltage the current taken from the line will be $\left(\frac{65}{100}\right)^2 \times 600 =$ 253.5 per cent, and the motor current equals $600 \times 0.65 = 390$ per cent of full-load rating. In the question the current referred to is the line current. The motor current under these conditions is probably about 400 per cent of rating.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

WOULD there be any difficulty in paralleling a direct-current motor alternating-current generator set, rated at 125-kva., with a 100-kva. turbine-driven alternator, the governor of which is not adjustable from the switchboard? The speed of the motor-generator set can be controlled by a rheostat in the motor's field circuit. Would it be necessary to increase the speed of the motor above that of the turbine after they are connected in parallel? With the turbine unit used as a synchronous condenser, could the power factor of the motor-driven generator be increased to 100 per cent? W.J.D.

THERE should be no difficulty in paralleling a direct-current motor-driven alternator with one that is turbine driven, even though the latter cannot have its speed adjusted from the switchboard. In this case the speed of the motor-driven unit can be adjusted by means of a rheostat, in series with the motor's field winding, to permit synchronizing the two machines.

After the two machines are connected in parallel, it will not only be unnecessary but impossible to cause one of them to run at a higher synchronous speed than the other. If it is desired to shift the load from the turbine-driven to the motor-driven unit, this may be accomplished in any one of three ways:

1. Set the turbine governor for a lower speed. This will cause both alternators to slow down some, but will at the same time cause the load to shift to the motor-driven machine.

2. Reducing the field strength of the direct-current motor will increase the speed of both alternators. This will cause the governor of the turbine, which is not set for this speed, to adjust the admission valve for a smaller input and the machine will relinquish load to the motor-driven unit.

3. Load may be shifted by a combination of methods 1 and 2.

It is misleading to say that we speed up an alternator to cause it to assume more load. Its speed cannot be changed without changing that of every alternator on the system. What the operator does is to change the setting of the governor so that, at a given machine speed, it will hold the admission valve wider open and thus permit the machine to supply more load at that speed. Nor is it correct to say that we slow an alternator down in order to make it drop load, as its frequency cannot be reduced below that of the system. The thing that causes a machine to carry less load is setting its governor so that at the speed of the system the admission valve is nearer the closed position.

With any ordinary load on the machines it is possible to obtain a power factor of 100 per cent on either machine by so adjusting its field that it takes the minimum current for a given kilowatt load. M. F. KNOY.

Lake Charles, La.

THERE need be no difficulty in paralleling the motor-driven generator with the turbine-driven machine. Presumably, this is an isolated plant, and the turbine governor can be adjusted by hand to bring the speed of the two machines into synchronism. It may be found desirable to install a rheostat in the direct-current motor's field circuit with smaller resistance steps than usual. This depends, of course, upon the existing equipment. If this plant is isolated, the speed of the motor can be varied so as to bring the two machines to synchronous speed, whether the motor-driven machine is the running or the incoming unit.

A study of the load-speed curve of each machine would have to be made, to determine if the machines will share the load reasonably uniformly, at all points between no load and full load. Some hand regulation would be needed to maintain a fair division of load. It might be possible to add a series winding to the direct-current motor, in order to produce the necessary regulation.

Once the two machines are in parallel, they have to run at their respective synchronous speeds. A reduction in the motor-field current will make this machine tend to speed up and the turbine-driven unit tend to do likewise. This increase in speed will cause the turbine governor to close down slightly and the unit to reject some load, which the motor-driven set will pick up.

There is no reason why it should not be possible to maintain unity power factor on the motor-driven set using the steam unit as a synchronous condenser. A knowledge of the actual power-factor conditions of the load would be necessary before this part of the question could be answered fully.

C. E. OLIVE.

Drummondsville, Quebec.

WITHOUT knowing more about the problem than was published, it would appear that the most economical way to operate the two machines would be the reverse of that suggested. This would avoid the conversion losses due to changing from direct to alternating current and also the losses incident to the cooling steam that must be allowed to flow through the turbine when the generator is operating as a synchronous condenser. If the turbine-driven generator has sufficient capacity to carry the kilowatt load, then by allowing the other machine to act as a synchronous condenser, the losses will be chiefly those in this machine. The motor's field current can be adjusted so that it will take very little power from the direct-current system. There is also the possibility of using a magnetic clutch between the motor and generator and disconnecting the motor from the generator, when the latter is operating as a synchronous condenser.

The foregoing is premised on the assumption that the machines will operate as synchronous condensers without hunting. Machines designed specifically for condenser and motor operation are provided with a squirrel-cage winding in the pole faces to prevent hunting. In these cases the squirrel-cage winding also acts as a starting winding.

Cleveland, Ohio. B. A. BRIGGS.

A Question For Our Readers

DOES the meter showing air flow to the furnace and the steam flow eliminate the CO_2 instrument as a necessary boiler-room adjunct?

L. M. D.

Suitable answers from readers will be paid for and published in the April 16 issue.

Steam Generatiom at

HIGH PRESSURES

and Temperatures

I. Preliminary Study

BY PROF. DR. ST. LOEFFLER
Technische Hochschule
Charlottenburg, Germany

FOR some time past engineers have been feeling their way toward greatly increased steam pressures. Only recently, however, has it been possible to arrive at any practical results in the shape of high-pressure steam plants. These were built in spite of warnings by many experts, among them, especially, men in charge of electric central stations. One of the chief arguments was that no appreciably improved thermal efficiency would be attainable with pressures above 35 atmospheres (500 lb. per sq.in., since the European "atmosphere" equals 14.2 lb. per sq.in.).

In making these assertions it is probable that the rise in pressure only was taken into consideration, without due thought being given to the accompanying simultaneous increase of the working temperature of the steam. By raising the steam temperature to the limits set by the endurance of the materials at present available, or in other words to about 500 deg. C. (930 deg. F.), the heat losses greatly decrease until a pressure of 130 atmospheres (1,850 lb.) is reached. Beyond 150 atmospheres (2,100 lb.) and particularly with condensing engines, the benefits gained no longer balance the difficulties and expense incurred in securing the added rise in pressure.

In developing steam power plants from low-pressure to high-pressure operation, considerable improvements in thermal efficiency, which may in some cases reach 50 per cent and more, are involved. The saving in coal will be naturally an ever greater factor of economy as the price of coal advances. It must also be considered that reduced coal consumption will be reflected in corresponding reductions in conveying means, coal-storage facilities, furnaces and boilers, drying plants and mills in the case of powdered-coal firing, attendance, and other items.

Coal, it should be remembered, is not only a fuel, but also the raw material for chemicals, dyes, and particularly for oils of the kind used in vast quantities as fuels in automotive engines. Hence it is by no means a far-fetched idea that restrictive legal measures to prevent the wasting of this precious material may at some near date result, unless the users themselves take steps in time to cut down heat consumption of their plants as far as possible.

In extending existing power plants the question of when the added power demand is likely to materialize must

This article is a highly interesting commentary on the generation and use of steam at high pressures and temperatures. It is also, frankly, an argument for the superiority of the Loeffler "steam-pumping" boiler over other existing types for such service. In spite of their controversial nature the author's arguments and comparisons are presented here in the belief that they will stir up much-needed hard thinking on the subject and lead to worthwhile discussion from interested readers. This first section of the paper deals with other types of boilers. The concluding part, to appear shortly, will discuss the Loeffler boiler.

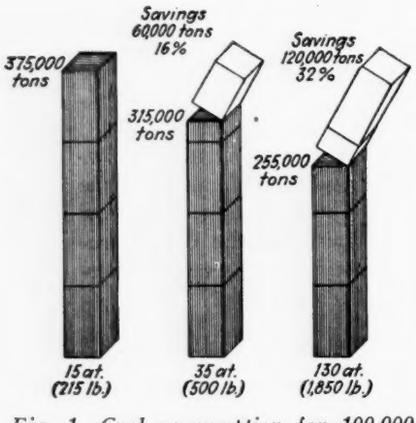


Fig. 1—Coal consumption for 100,000 kw. condensing plant, 6,000 hours' operation

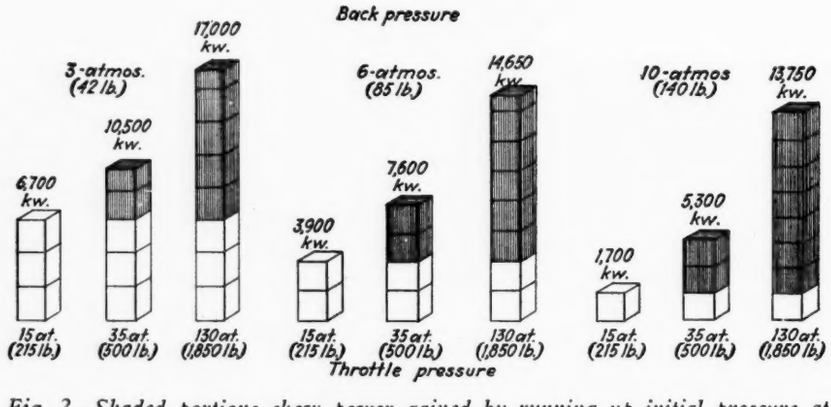


Fig. 2—Shaded portions show power gained by running up initial pressure at various back pressures for engine or turbine delivering 100 tons of steam per hour to process and heating

also be considered in judging the influence of pressure upon economy of operation. The jump from 15 to 35 atmospheres (215 to 500 lb.) has been risked, although the additional costs for equipment amount on an average to about 30 per cent, while a heat gain of only about 15 per cent is realized with a power plant of the pure condensing type. It takes, thus, several years before the added capital investment can be made good by the improved operating economy of the plant.

By raising the pressure from 35 to 120 atmospheres (500 to 1,700 lb.), a further saving in fuel nearly as great as the former is to be had if the steam temperature is simultaneously increased above 450 deg. C. (850 deg. F.) and reheating is applied. As at the same time the cost of a high-pressure plant built along modern lines is not appreciably higher than that of a low-pressure plant, it will be seen that in fact the gain is nearly twice that for the change from 15 to 35 atmospheres.

And yet such a step is rarely undertaken today because, in addition to the fear of high pressure and high temperature, the estimate of the economy of a new high-pressure plant is adversely influenced by considerations of the load factor.

Such a manner of judging the economy of a plant, however, is one-sided and frequently erroneous. For it is better in any case to allow the more efficient high-pressure plant to work under full load as long as possible and to use the existing low-pressure plant only as needed. With the problem viewed in this light, it will become clear that the erection of a high-pressure plant will be desirable under all circumstances.

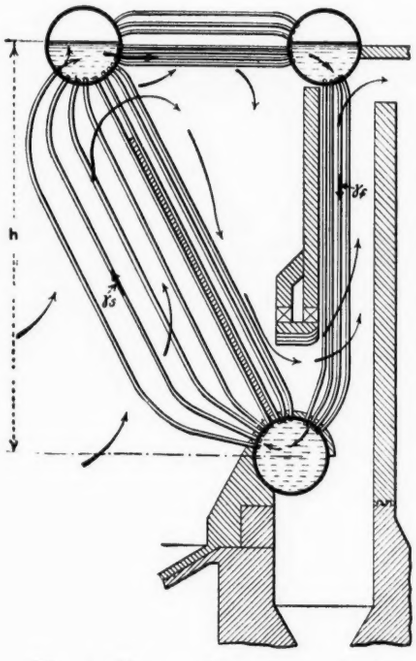


Fig. 3—Heat and water circuits in a three-drum boiler

γ_f = specific weight in descending tubes
γ_s = specific weight in ascending tubes

A similar reasoning applies to central heating plants, because steam for this purpose is frequently, and especially in the case of municipal heating systems, required during only part of the year. A super-high-pressure plant is usually advantageous only when it is possible to dispose of the current generated in back-pressure operation. Still better economy is attained by generating current with condensing operation of the engines during the time when no steam for heating is required. Here, too, it will be advisable to shut down for a time existing and less efficient low-pressure plants. Never will live-steam, low-pressure heating plants, the erection of which has been repeatedly recommended, be more economical in operation than super-high-pressure combined heating and power stations, regardless of how much less the cost of low-pressure boilers may be than that of high-pressure boilers.

Fig. 2 shows the gain in electrical output of a heating-power plant generating 100 tons of steam per hour at live-steam pressures of 15, 35 and 130 atmospheres (215, 500 and 1,850 lb.) at different exhaust-steam pressures of 3, 6 and 10 atmospheres (42, 85 and 140 lb.)

Pulverized Coal and High Pressures

An important point in the development of an economical, dependable and flexible steam power service is the improvement in boiler firing to be obtained through the use of powdered coal. Indeed, it is only by this means that complete control and easy regulation of the fire effect, and hence of steam generation, is realized. By using the new radiant-heat type of boiler, with its capacity to adapt itself rapidly to any fluctuation in the steam consumption, powdered-coal firing may also render superfluous the use of steam accumulators as a means for compensating fluctuations of load.

With high pressure a point of essential importance is the reheating of the steam. It is necessary, especially with multi-stage turbines, in order to avoid the injurious effects of moisture in the low-pressure stages. Though reheating does not greatly improve the thermal efficiency, it improves it sufficiently to pay for even a certain amount of added complication of the plant.

The fears expressed by experts concerning high pressures and particularly high temperatures are, indeed, not without foundation as long as we think of the production of steam in boilers of the low-pressure type at present generally used, which defy anything like positive control. New methods for generating steam have, however, been developed which have been proved by extensive trial to permit of a sure control of very high pressures and temperatures, so that today it is safe to make the change to high pressure.

Standard Boilers for High Pressure

The inadequacy of the old boiler types is generally realized today. Nevertheless, attempts have recently been made to adapt vertical-tube and drum boilers to pressures of 100 atmospheres (1,400 lb.) and more, merely by increasing the wall thickness and by trivial alterations in the construction. Types of boilers have even been proposed for such pressures—for example, two-drum boilers—which have proved to be inferior even with low-pressure operation. All this is done

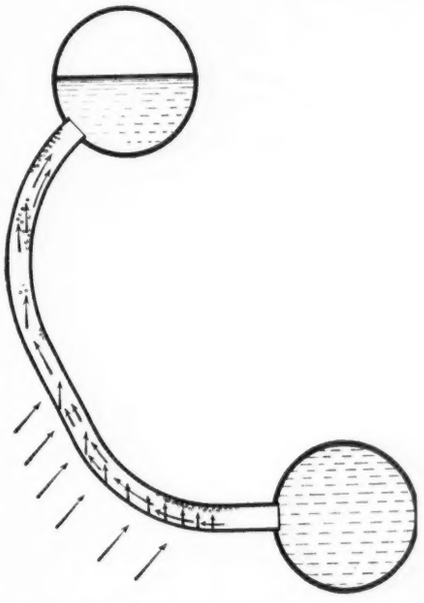


Fig. 4—Movement of steam in bent tubes of a vertical-tube boiler, showing accumulations of steam bubbles

mainly to hold down the first cost of boilers; nevertheless, with high pressures boilers built along customary lines become too expensive to permit of economical steam generation.

There can be no doubt that it is possible, by increasing the wall thickness, to adapt a boiler of any of the old types to the generation of steam at any higher pressure. It is quite another question, however, whether such a boiler is to be considered safe also at super-high pressures and temperatures in view of the present tendencies aiming at absolute control of operation. For even with low pressures the operation of such boilers is permitted only under rigid regulation and continuous official supervision.

Within all boilers hitherto used, the circulation of water is produced and maintained only by differences in temperature. Fig. 3 gives a diagrammatic representation of the water circulation in a three-drum vertical-tube boiler, which has been the most widely used type of late. The water circulation is depended on for conducting to the upper drum especially the steam bubbles developing in the front bank of tubes as soon as they are formed, and for immediately supplying new water from the rear tubes to the bottom drum. As soon as steam forms in the rear tubes—and there is no positive means of preventing it—the intended circulation of water is disturbed and there is danger of the front tubes burning

through, exposed as they are to very high rates of heat transfer.

The necessary bend in the tubes is an obstacle to the flow of the steam bubbles to the upper drum, as may be seen from Fig. 4. In rising, the bubbles formed below unite with those originated higher up and stick to the tube wall. Numbers of such bubbles join to form nests, which are the harder to dislodge by the water flowing past the more the

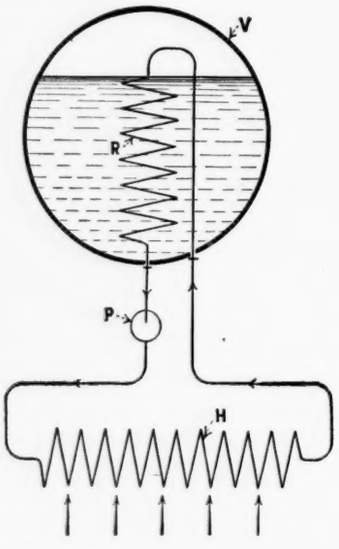


Fig. 5—Indirect steam generation by means of a mechanically circulated heat carrier

H — Heated tube coil; *P* — Circulating pump; *R*—Vaporizing coil; *V*—Vaporizer.

tube is bent. With the nearly level tubes of sectional boilers, in particular, there is grave danger of bubbles collecting and tubes thus burning through because of insufficient water circulation.

Now the higher the pressure the smaller are the bubbles and the slower their rising and the circulation of water. The difficulties and dangers connected with insufficient circulation grow, therefore, steadily as the pressure rises, and it thus becomes even more imperative to avoid everything that may constitute a source of trouble already found with low-pressure boilers. Above all, any deposit of scale must be prevented. This makes it compulsory to use pure distilled water, although even this does not preclude the possibility of the tubes burning through. And especially under high pressure, distilled water is capable of an action similar to that of an acid. To prevent this, the water must be mixed with alkalies, for which reason there has lately been a return to chemical purification.

The rolling-in of the tubes renders it necessary to use tubes of soft steel, and the grain of such steel is adversely affected by the excessive working (stretching) unless this is followed by annealing. Added to this are the difficulties of rolling the tubes into the thick walls of the drums for high-pressure boilers. Moreover, the many perforations of the boiler give rise to supplementary stresses to such an extent as to render it necessary to make the walls about twice as thick as would be demanded by consideration of pressure and temperature only. The strains produced by the rolling-in process have a particularly unfavorable effect at the internal surface of the drum, which already is subjected to the greatest stresses.

The aim in high-pressure construction is therefore to make the diameter of the drums as small as possible. This procedure does, indeed, reduce the first cost of the drum, which is forged from a solid steel billet, but at the same time it cuts down the water content essential for compensating for changes in load and still further increases the difficulties of rolling-in the tubes. This again has led to reducing the number and increasing the length of the tubes, culminating in the design of so-called "tower-like boilers," which require a special elevator for the attendants.

A certain height h, Fig. 3, is necessary for reasons of water circulation, because this circulation is chiefly dependent upon the difference in weight of the water in the ascending and descending tubes $h\ (\gamma_f - \gamma_s)$. Very long tubes, however, have other disadvantages. The resistance to circulation, as well as the length of travel of the steam bubbles, is increased. In their long path, the steam bubbles tend to become saturated with moisture and impurities, the result being wet, impure steam, tending to produce difficulties in the superheaters and engines. Finally, there is the danger with long and narrow tubes, of only steam being present near the entrance points into the upper drum, the walls thus being water-free and exposed to the danger of burning through.

Double-Fluid Boilers

For this reason attempts have long been made to discover processes for generating steam which permit of a better and, if possible, a positively controllable rate of steam generation. In particular, endeavors are being made to transmit the heat to the water indirectly by circulating a liquid heat carrier, as indicated in Fig. 5. With forced circulation maintained by means of a pump, the carrier is heated in passing through a furnace *H* and caused to give up the heat there acquired through pipe coils *R* to water contained in a drum *V*, thereby generating steam. Various media have been proposed to serve as heat carriers, such as mercury, molten metals, naphthalene and oils.

In translating these proposals into fact, difficulties were encountered, due to peculiarities in the behavior of the heat carrier at different temperatures, to its forced circulation, to chemical changes in the carrier when used for any length of time, and finally, though not least, to leakage. Additional troubles arise with the heating surface *R* in the evaporator *V* through the rapid drop in the rate transfer occasioned by deposits of impurities, boiler scale or bubbles on the exterior walls of the heating-tube surfaces. For this reason no such steam generator has ever attained any practical importance.

The recent Schmidt-Hartmann high-pressure boiler shown in Fig. 6 is based on this idea, but makes no use of forced circulation of the heating medium (distilled water). Instead, it depends, as do ordinary boilers, on the difference in weight of the water in the ascending and descending tubes, this circulation being aided somewhat by a cooler *K* in the descending line, which preheats the feed water by means of the condensed heating steam. The heating steam produced from distilled water in the fired vaporizer coil *H* is separated in the drum *D* and, by condensation in the heat exchanger *R*, yields its heat for generating steam in the vaporizer drum *V*.

With this automatic circulation of the water are associated all the various troubles that may arise with ordinary boilers; to these must be added leaks in the water circulation piping, and the

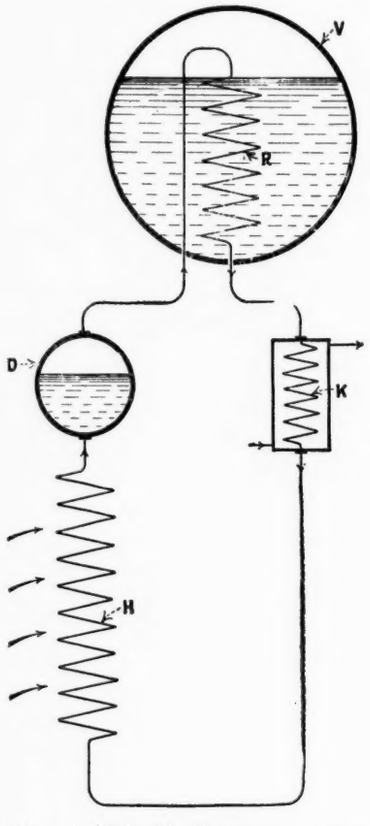


Fig. 6—Schmidt-Hartmann steam generating process

H—Heated tube coil; *D*—Steam collector; *R* — Vaporizing coil; *V* — Vaporizer; *K*—Cooler.

indirect heat transfer in the boiler, as possible sources of disturbances. The design also becomes more involved, and hence more expensive, than that of ordinary vertical-tube and sectional boilers.

Even with the heating surface of the coil *R* absolutely clean, the pressure of the heating medium is bound to increase heavily with rising working pressure. With pressure differences of from 20

to 40 atmospheres (300 to 600 lb.), impurities or boiler scale would be deposited on the outside surfaces of the coils R in the vaporizer V. Even very light scale deposits are capable of strongly affecting the generation of steam.

The problem of attendance to the coils built into the vaporizer drum V is

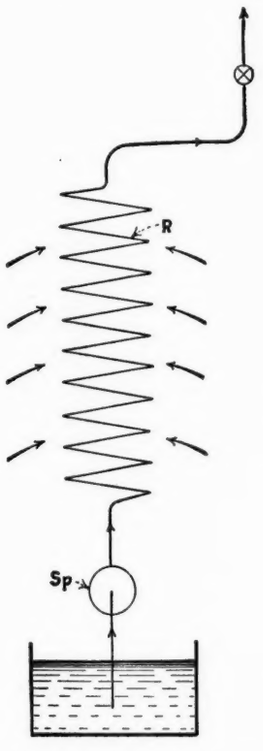


Fig. 7—Steam generation with forced circulation of feed water through heated tube coil R by means of pump S_p

not simple, apart from the fact that they reduce the available water space in the vaporizer as well as the steam passage. The water level in the vaporizer must be maintained practically constant, since less steam is generated as soon as the coils are no longer entirely immersed in water. Two water levels have, moreover, constantly to be watched, a second water gage being required for the steam collector D to show leaks in the water circulation and to permit compensation for loss of water by means of a force pump provided for the purpose.

The vaporizer V and the steam collector D must be arranged at the highest point of the furnace; consequently, no constructional advantage over ordinary boilers accrues. And finally, there still remains the lack of control in operation, which may be affected not only by the condition of the feed water and the heating surfaces, but also by variations in the circulation of the water used for heating.

As long as fifteen years ago Doctor Havlicek, who must be ranked among the foremost pioneers of high-pressure steam operation, suggested steam generation at the critical state of 225 atmospheres (3,200 lb. per sq.in.) and 375 deg. C. (707 deg. F.). In a later design by Doctor Benson, shown diagrammatically in Fig. 7, water is fed by the pump S_p at critical pressure and then heated in tube coils R to the critical temperature. The water is thus gradually heated and then suddenly converted as a whole into steam without the formation of bubbles. By means of a throttle the steam so generated is reduced to the working pressure and, after superheating, is taken to the engine.

A steam collector of the ordinary type which contains water cannot be used with this boiler. For this reason it is neither possible to eliminate impurities entrained by the steam, nor to compensate for fluctuations of load at the point of steam generation. Instead, thermal storage apparatus must be provided, the usual location being within the low-pressure circuit of the steam plant. With heavy fluctuations of the load, however, this heat storage may react unfavorably upon the high-pressure circuit and the steam production, and it constitutes an expensive boiler accessory under all circumstances.

With coal firing it will undoubtedly not be easy to maintain a uniform control of the generation of steam in several parallel water-tube coils. As a result of unequal movement of the water and of differences in the heating of the coils, it is easy for wet steam to be formed. Therefore, with the Benson boiler also, there is no positive control of steam generation.

The velocity of flow in the pipe coils is determined by the load on the boiler and the amount of feed water to be moved. High velocities are impracticable because of the large resultant power required of the feed-water pumps, and any sudden drop in load which is not followed quickly enough by a corresponding diminution of the heating is likely to endanger the tubes, especially when the water is impure. To say the least, impure water would constitute a considerable element of risk with the Benson boiler.

[*Dr. Loeffler's second article, which will continue this discussion with special application to his "steam-pumping" boiler, will appear in an early number.*—Editor.]

Two-Pressure Steam Generation

THE following comments on two-pressure steam generation are taken from the March number of *The Power Engineer,* London:

"A particularly interesting paper was read before the Institution of Mechanical Engineers recently by Mr. J. G. Weir on the subject of "Modern Feed-Water Circuits."

"Roughly, the scheme is to withdraw water from a normal-pressure boiler for use as feed for a high-pressure boiler, the boilers often being in series also on the flue-gas side. The high-pressure steam is fed to a turbine which exhausts at the pressure of the low-pressure boiler. The two steam supplies then commingle and are used in turbines of normal type.

"Thermodynamically there appears to be no particular reason why such an arrangement should warrant the extra complication, but several advantages of a practical nature can be advanced. Probably the idea originated in the desire to modernize existing power plants without wholesale reconstruction. The outstanding advantage of the arrangement is that high-pressure boilers and turbines can be added to an existing plant, the station, as a whole, partaking in the superior performance due to high-pressure steam without the expenditure of huge sums on replacing equipment already in commission. A further advantage is that the high-pressure units may be kept at a constant rating and variations in demand taken on the low-pressure units. High-pressure boilers are as yet somewhat circumscribed in their flexibility and in the range of load over which they are efficient; the method of operation outlined overcomes these disabilities. Especially when the low-pressure units are of the cylindrical type the flexibility of the high-pressure units is greatly increased owing to the accumulator effect of the low-pressure boilers. Another practical point is that any scale or sludge tends to be left in the low-pressure boilers, where its presence is less deleterious.

"Several contributors to the discussion supported the proposal conditionally on the flue-gas circuits being connected in series, preferably with one fire serving both boilers. The latter element in the condition rather leads the proposal away from what we believe to be its original intention—the retention of existing boilers and turbines. However, the argument in favor of connecting the flue-gas circuits is worthy of consideration. It is contended that a straight high-pressure boiler entails a flue-gas exit temperature so high that to bring it down by means of economizers and air preheaters to a reasonable value would result in excessive feed and air heating. A low-pressure boiler, however, would take account of this extra temperature drop, and may even replace air preheaters and economizers altogether.

"While the arguments in favor of two-pressure generation have undoubted weight, answers can be found for several of them. For instance, flexibility and shape of the efficiency curve are questions of design, and improvements can be expected in the normal course of development. Again, the increasing use of deaërators, evaporators and closed-feed systems is overcoming the scale problem. Then the contention that the amount of air preheating necessary for efficiency with high-pressure boilers is excessive is probably true enough when chain-grate stokers are used, on account of maintenance costs, but such limitations on air preheating are not imposed in the case of pulverized-fuel-fired plants.

*Modern Stoker Development**

By C. F. Hirshfeld and G. U. Moran
The Detroit Edison Company

A review of stoker development over a period of years indicates that fuel-burning capacity and total heat release per furnace have tripled, while the heat release per unit of grate area has doubled, showing that dimensions have increased more than intensity of use. Present trends with stokers seem to be toward relatively smaller furnaces and operation of boilers at successively higher ratings.

As an introductory to this general subject, G. U. Moran and C. F. Hirshfeld, of the Detroit Edison Company, considered the evolution of the forced-draft chain or traveling grate and the multiple-retort underfeed stoker, as well as certain other factors that entered the picture, such as larger boilers and furnaces, increased steam output per square foot of surface, water cooling of furnace walls and the use of preheated air. Following these preliminary remarks the authors proceeded to a more detailed consideration of the status now reached in the development of the stoker.

Present Status of Stoker Development

Great progress has been made in fuel burning capacity through the increase of stoker dimensions and the increase of fuel-burning capacity per square foot of grate area. The increase of stoker dimensions has occurred both laterally and longitudinally. Increase of width tends to increase the fuel burning capacity in direct proportion, except for a slight difference due to the diminishing effect of side wall conditions. Increase of length produces more than a proportionate increase in fuel-burning capacity, at least up to a certain limit not yet determined.

With the chain grate the increase of width and length has brought serious problems of mechanical design and air distribution. In the multiple-retort stoker increase of width is a comparatively simple matter, but increase of length has brought up problems of mechanical strength, adequate coal feed and adequate coal forwarding.

Increase during the last few years, in coal-burning capacity per stoker-fired furnace is shown in Fig. 1, in which results obtained with both chain grates and underfeed stokers have been combined. The figures used are those given by the manufacturers of the stokers as maximum continuous possibilities.

Fig. 2 shows the total heat release per furnace, thus eliminating variations in heat value of the coal. It will be seen that both figures have about tripled in a period of thirteen years.

Data represented in Fig. 3, showing the increase in the rate of heat release per square foot of grate area over the same period, indicate a less rapid change, as the rate has hardly doubled. The inference is that a great part of the increased output per furnace has resulted from increasing the stoker dimensions rather than the intensity of use.

It has long been known that stoker-fired equipment is not so limited with respect to rate of heat release per unit of furnace volume as equipment fired with pulverized fuel. Cases are on record in which reasonably good results were obtained with stoker-fired furnaces having a rate of heat release approaching 100,000 B.t.u. per cu.ft. per hour. It is, however, realized that furnace volumes have increased greatly since the early years of this century, and naturally some confusion exists as to the exact status of the art at the present time.

It is impossible to give any simple rule for furnace volume, as too many variables are concerned. It might, however, be stated that as walls become better protected with air-cooled, water-cooled or steam-cooled surfaces, and as more highly preheated air is used, the rate of heat release per unit of volume may increase without materially affecting the operating results. The principal limit is set by the tendency to deposit fused ash on the boiler tubes nearest the furnace. This can be obviated by the use of an adequate slag screen arrangement; that is, by the use of one or more rows of widely spaced tubes that cool the molten fly ash before it can adhere to closely spaced tubes.

Fig. 4 shows how improvements in the furnace construction have affected the rate of heat release in recent years. The general trend has been toward relatively smaller furnaces with stoker firing during the last decade. This is explained partly by the facts previously stated and partly by a sacrifice of the advantages of large furnace volume in exchange for smaller investment.

Effects upon the boiler of high rates of heat release per furnace and per unit of furnace volume are shown graphically in Fig. 5. Apparently, boiler area has not been increased continuously at the same rate as has the rate of heat release per furnace, which is equivalent to saying that boilers have been operated at successively higher rates of output. The tendency toward lowered thermal efficiency has been balanced by extensive use of economizers and air preheaters.

Increase in the quantity of steam produced per furnace is shown in Fig. 6. While it is true that the highest values shown do not as yet represent accomplished facts, they do represent actual orders placed.

Equipment Generously Large Favored

Experience shows that the purchase of stokers generously large for the job pays handsome returns. Such action makes the operator more independent of variation in the quality of the fuel supply and better able to cope with the various vicissitudes of daily operation.

Similarly, when choosing the motive power for stokers, one should not be satisfied with something that figures just large enough on the basis of calculated maxima. There should be a generous allowance above the apparent maximum requirements for fuel feed. It is frequently necessary to build up a fire rather hurriedly while at the same time burning at a rapid rate, and this obviously calls for a great surplus over the calculated maximum speed. Too many installations are limited in this respect. At the present time most stokers, and particularly those of large size, are motor driven. It pays to expend the few extra dollars required to obtain a generously large motor, and also to have a great many control points, or the equivalent, so that when the character of the load permits, the speed may be adjusted so as to prevent undesirable building up or thinning of the fire. It also is important to make certain that the motor, when operating at the lower speeds, will have sufficient torque to drive the stoker satisfactorily.

It has been found that it is usually not safe to base the choice of forced-draft fan characteristics upon too optimistic a conception of the performance of the stoker and the furnace. Even though the expectation is to maintain 14 per cent CO_2, the fan should be large enough to deliver the air required for maximum combustion with a much lower CO_2 performance. As a general rule something of the order of 11 per cent should be used for cases in which 14 per cent is to be expected. With such capacities emergency conditions may be met with an assurance of safety. Similarly, the maximum air pressure at maximum output should represent a generous margin of safety over the discharge pressure called for by the stoker manufacturer.

Proper speed regulation, a problem

*Abstract of paper read before the Mid-West Power Engineering Conference, Chicago, Feb. 12 to 15, 1929.

that many believe, has not as yet been satisfactorily solved, is important. Direct-current drive is beautifully flexible, but costly in all respects. Alternating-current drive becomes complicated and costly, if the desirable flexibility is approximated. It seems as though the best solution for general application is a combination of damper and speed control in which the power losses resulting from dampering are offset by lower first cost, less complication and less maintenance expense.

Similar remarks apply in general to induced-draft fans, although possibly they should not be properly considered as part of the stoker installation.

Proper Distribution

It is important to distribute coal properly to a stoker, as the stoker should not be held responsible for results if coarse coal is fed to one or two retorts and much finer coal to the neighboring retorts. This fact has been known for a long time and appreciated by some, but ignored by many. There are several different devices on the market that are capable of producing satisfactory distribution of coal in the stoker hopper, and these devices should be used more frequently.

Automatic Control Has a Place

The authors believe that there is no need to contemplate in the near future any automatic combustion control that will give results better than, or even as good as, can be obtained by a conscientious, careful and skillful operator properly assisted by instruments and other facilities. However, this should not be interpreted as meaning that there is no field for automatic control of stoker operation. In the first place, operators of the type indicated are rare, and there are now available automatic combustion-control systems capable of giving better results than are obtained by many of the stoker operators now employed. In the second place, it is wrong to expect the best results when a man is used to do the job a machine can do as well or better, and thus uses up a good part of his energies instead of conserving them for doing only those things he can do better than an available machine.

For the foregoing reasons automatic control was favored to a certain extent, even when good operators were available. The degree must vary with the economics of the particular situation as determined by the cost of fuel, cost of labor, size of unit, etc. In the simplest case the automatic feature might be confined to boiler damper control, while at the other extreme would fall complete automatic control of all factors in an over-all way and according to certain mean requirements, leaving the skilled operator free to make such secondary refinements in the relations between the different parts of the equipment as his experience might indicate to be necessary.

The paper included several illustrations of present day stoker installations. A section through one of the Crawford Avenue boilers was shown as a typical arrangement of forced draft chain grate stoker of the largest size used with Illinois coal. The stoker is 24 ft. wide by 20 ft., 6 in. long and is designed to produce 150,000 lb. of steam per hour continuously.

Several illustrations of typical large under feed stokers were shown. One of these was an English installation in a plant known as Deptford East. This is a 17 retort, 49 tuyere stoker that is to produce 350,000 lb. of steam an hour continuously.

Of special interest are the underfeed stokers ordered for the new Delray No. 3 plant of the Detroit Edison Company. This stoker has 15 retorts and is 57 tuyeres long. The continuous steaming capacity has been placed at 350,000 lb. per hr.

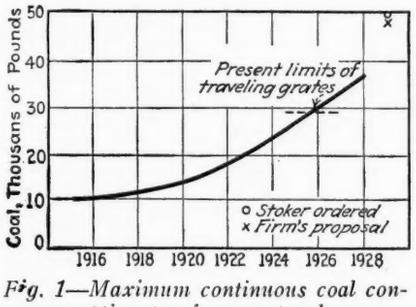

Coal, Thousans of Pounds
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Fig. 1—Maximum continuous coal consumption per furnace per hour

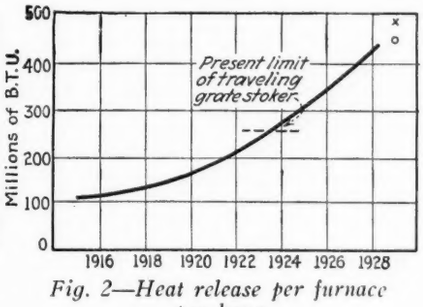


Fig. 2—Heat release per furnace per hour

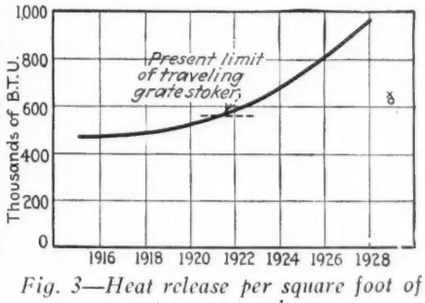


Fig. 3—Heat release per square foot of grate area per hour

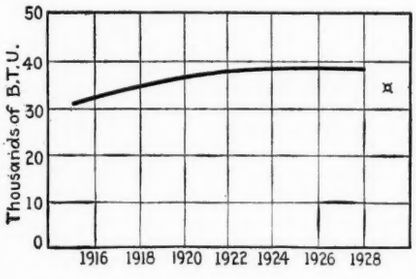


Fig. 4—Heat release per hour per cubic foot of furnace volume

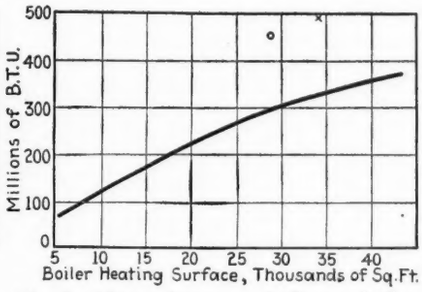


Fig. 5—Heat release per boiler vs. boiler surface in square feet

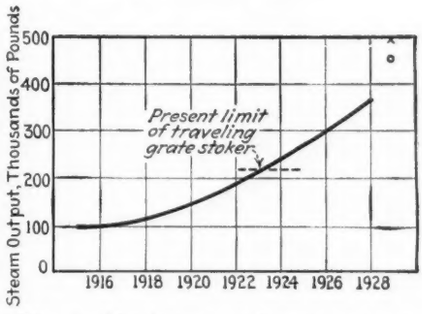


Fig. 6—Maximum continuous evaporation per boiler per hour

Power Pond as Swimmin' Hole

By A. L. H. Street

IN A recently decided case—Maruska vs. Missouri, Kansas & Texas Railroad Company, 10 South Western Reporter, 2d Series, 211—the Texas Court of Civil Appeals reviewed court decisions bearing on the liability of those who maintain ponds and lakes in connection with the operation of power plants, etc., for injuries to trespassing children. Following these precedents, the court holds that where a pond or lake is not so situated with relation to an immediately adjacent highway or passageway as to be inherently dangerous unless fenced, there is no obligation to fence it, to avoid drowning of children. The opinion approves the following quoted summary of judicial views from various states:

"Ponds, pools, lakes, streams and other waters embody perils that are deemed to be obvious to children of the tenderest years; and as a general proposition no liability attaches to the proprietor by reason of death resulting therefrom to children who have come upon the land to bathe, skate or play. . . . Although a property owner may know of the habit of children to visit waters upon his premises, he is as a rule under no obligation to erect barriers or take other measures to prevent them being injured thereby."

Things One Should Know

ABOUT FOREIGN PATENTS

By Leo T. Parker
Attorney at Law, Cincinnati, Ohio

Before inventors decide to obtain foreign patents several things should be considered, such as the foreign yearly license fees, and the requirements of making and selling the invention within a specified time. While a patent is a negotiable government grant giving the patentee the exclusive right to make, sell and use the invention, the patent laws of foreign countries are vastly different from those of the United States and are not so liberal.

IT IS the purpose of this article to review the important higher court decisions involving various phases of the advantages and disadvantages of obtaining foreign patents, so that inventors and manufacturers in this country may readily determine whether foreign patents may prove profitable.

Some Advantages of Foreign Patents

A United States patentee who fails to obtain patents in foreign countries is forever denied the *exclusive* right to make, sell and use the invention outside the limits of this country. Obviously, this may result in keen foreign competition should the inventor later decide to market his product abroad. Since the patentee is unable to exclude others from manufacturing his invention in foreign countries, often he is confronted with complex difficulties of controlling its exclusive sale in the United States. This is true, particularly, because no person or firm is liable for infringement of a United States patent unless it is proved to the satisfaction of the court that the complete infringing acts are done within the United States.

For example, in the recent leading case of Toledo Computing Scale Company vs. Computing Scale Company, 279 F. 648, the inventor of a mechanical scale obtained only a United States patent. An unlicensed United States manufacturer made several elements of the invention in this country and a subsidiary company made other parts in Canada. Contracts for sale of the product to Canadian dealers were executed by the manufacturer's agents in this country. The parts of the scale manufactured in the United States were shipped into Canada and assembled there, with the parts made in the latter country, into infringing machines.

The patentee sued the firm that manufactured the parts in this country. However, the higher court held this manufacturer not liable and explained the law, as follows:

"Defendant (manufacturer) made profits on sales of cylinder scales in Canada, but no completed scale was ever shipped to Canada. Some parts were manufactured in Canada, and some were made here and shipped there; but the parts were there assembled into completed scales and there delivered to Canadian users. Because some of the parts were made in this country, complainant (patentee) insists that defendant (manufacturer) is to be held here as a contributory and infringing maker. But contributory infringement can arise in this country only when *somewhere and somehow in this country there is a completed infringement* to which a contribution can be made. An additional urge is that the manufacturer is liable as an infringing seller in this country because Canadian salesmen sent the orders to defendant's offices in Toledo for approval. Complainant is doubtlessly right in saying that the contract was executed, but not in the same sense as performed, in this country."

Therefore, it is quite apparent that if this inventor had obtained a patent in Canada, all parties, both in this country and in Canada, would have been infringers. However, under the circumstances explained the manufacturer was permitted without liability to make certain parts of the invention in the United States and ship them into Canada.

Rights of Foreign Purchaser

Another common source of litigation is where a foreign user purchases patented equipment from a United States manufacturer located in a foreign country and later reships it into the United States and offers it for sale.

It is established that a United States patentee who sells his patented product to a foreigner may not prevent the buyer from reshipping the equipment into this country and selling it here, unless the contract of sale restricts the purchaser.

For instance, in the latest and leading case of Curtiss Aëroplane & Motor Corporation vs. United Aircraft Engineering Corporation, 266 F. 71, it was disclosed that a United States patentee manufacturer sold a large quantity of airplanes to the British government for use during the World War. The airplanes were manufactured in Canada, and the contract of sale did not restrict the future use or sale of the equipment. At the end of the War a great number of the airplanes were shipped into the United States and offered for sale at very low prices. The patentee filed suit against the sellers for infringement, contending that a purchaser of articles made in Canada, under patents issued by the latter country, had no right to ship them for the purpose of sale into the United States without paying a royalty for the privilege. However, the court held that since the contract of sale contained no restriction as to where the equipment was to be used, the purchaser was within his rights to ship, sell or use the airplanes in the United States.

Also, it is well established that a person who resides in the United States and purchases a patented device from a United States manufacturer who has license to make and sell the device in *only* one state or locality in the United States, may without liability *resell* the device to any person located in any state in the United States. This is true irrespective of whether other manufacturers have exclusive licenses to make and sell the device in the locality in which the device is resold.

On the other hand, the law is well established that a person is liable for infringement who resides in the United States and, without authority of a United States patentee, imports into this country a product made in a foreign country. Under these circumstances *all* persons who sell or use the device in this country are liable as infringers (170 F. 70).

In many instances devices patented only in the United States have been made in foreign countries and smuggled into this country for sale here. Under these circumstances the patentee may experience great difficulty in identifying the many small sellers and users of the infringing devices. If, however, he can locate them, they are liable as infringers. But it is important to know if the inventor owns a patent in the foreign country from which the devices are being smuggled, he can immediately obtain a foreign injunction against further manufacture in that country and thus destroy the basic source of the infringement.

A United States inventor who obtains a foreign patent may protect himself

by making a contract by which a foreign firm is given the right to make, sell and use the invention in the foreign country, with the further agreement that the licensee may not make, sell or use the patented product in any country or locality except that which is specified in the contract.

On the other hand, in order to prevent confusion in the mind of the reader, it is well to explain that while a United States patentee may restrict the foreign manufacture, he may not prevent a purchaser of the invention from the foreign manufacturer from importing it into the United States and using it here.

For example, the Supreme Court (133 U. S. 702) held that:

"The franchise, which the (United States) patent grants, consists altogether in the right to *exclude every one from making, using and vending* the thing patented without the permission of the patentee. This is all he obtains by the patent. And when he sells the exclusive privilege of making or vending it for use in a particular place, the purchaser buys a portion of the franchise which the patent confers. He obtains a share in the monopoly, and that monopoly is derived from, and exercised under, the protection of the United States. . . . But the purchaser of the implement or machine for the purpose of using it in the ordinary pursuits of life stands on different ground. In using it, he exercises no rights created by the act of Congress, nor does he derive title to it by virtue of the franchise or exclusive privilege granted to the patentee. The inventor might lawfully sell it to him, whether he had a patent or not, if no other patentee stood in his way. And when a machine passes to the hands of the purchaser, it is no longer within the limits of the monopoly."

Making Without Sale in This Country is Infringement

Considerable controversy existed, with varied opinions, whether a non-licensed United States manufacturer may make a patented device in this country for the purpose of exporting and selling it in foreign countries in which the inventor has obtained no patents. This phase of the law was covered by the Supreme Court in the case of Hoover Manufacturing Company vs. Cowing, 105 U. S. 253. In this case it was held that any person who *makes* in the United States a device patented in this country is liable for infringement, although he intends only to sell it in foreign countries.

However, in the case of Dowagia Manufacturing Company vs. Minnesota Moline Plow, 235 U. S. 641, a fine line of distinction was drawn between the rights of a manufacturer and a jobber. In this case it was disclosed that a United States manufacturer infringed a United States patent by manufacturing a patented product. This manufacturer sold the infringing devices to a jobber who proceeded to sell some of them in Canada and some in this country. It is important to observe that the jobber was held liable in damages only for the articles he sold in *this* country, whereas the manufacturer was held liable in the damages and profits on *all* the articles he had manufactured and sold to the jobber.

So, therefore, an inventor who has patents in the United States and foreign countries, may prevent any person or firm from making, selling, or using the device in either this country or the foreign ones. Also, he may by contract prevent a foreign licensee from reshipping the product from the foreign country into the United States for sale, but cannot prevent a foreign purchaser from using the invention in this country.

Laws of Foreign Countries

In the United States an inventor is not required to manufacture or offer his patented device for sale. Moreover, he is not required to pay a yearly tax.

An inventor who has no foreign patents may not prevent United States manufacturers from making *all but one* of the parts of the patented device in this country, and then shipping these parts into foreign countries to be assembled there with the one part made outside the United States. This is true because complete infringement must be effected in this country, otherwise the inventor has no recourse.

In other words, a United States patentee retains his patent rights for seventeen years, although he refuses to permit the public to benefit from his invention.

However, this is not so in the majority of foreign countries. For instance, in England a patentee is required to begin the actual manufacture, commonly known as "working" of the invention, within four years from the issue of the patent. If at any time the manufacture and sale of the invention in England is purposely hindered by the patentee, and the public need for the article is not being supplied, or if the licensee contract made with the inventor is unreasonable, any person or firm may apply to the Comptroller of Patents of England, who will use his discretion and either grant a license to a foreign applicant on reasonable terms, *or he may revoke the patent.* Moreover, the patentee must pay a yearly tax to maintain the patent alive.

In France, and Italy "working" of a patented invention is required within two or three years from the date the application for a patent is filed. Also, a heavy tax is payable each year.

In Germany, no "working" is required, but the patenteee must pay a heavy tax yearly.

In Canada "working" is practically required within four years from the date of issue of the patent. However, the patent is not forfeited by non-working, but the Commissioner of Patents may grant a license to any person who applies to manufacture and sell the invention in Canada. Reasonable royalty is payable to the patentee. No yearly taxes are payable.

In Norway, Sweden and Spain no "working" of a patent is required, but after three years the inventor may be compelled, if the government elects, to issue a license on reasonable terms. A tax is payable each year regardless of whether the invention is manufactured.

In Holland "working" must begin within five years from the date the patent is granted.

In Switzerland no "working" is required provided the invention is being made in the United States.

In Belgium "working" is required within one year from the time the invention is being manufactured elsewhere.

Yearly Taxes in Foreign Countries

The yearly tax required to maintain a patent valid in some countries is excessive. If it is not paid, the patent is automatically forfeited, the inventor losing all rights to the patent.

In France taxes are due annually from the date of the filing. The amount payable during the first five years is $18.50 per year; the next five years is $23.50 per year; and the next five years $32 per year. "Working" is required within two years from the date of the grant of the patent and every two years thereafter. Each "working" costs the inventor an additional government fee of $30.

In Germany the taxes are payable annually from the date of filing. The first ten years the taxes amount to $300. The following eight years they increase to $1,600.

In Great Britain the taxes are payable each year after the first four years from the date of filing the application for a patent. The taxes for the first four years are included in the final government fee. They average above $50 each year threafter.

In Italy the taxes are payable annually from the date of filing the application. They average about $30 each year over a period of fourteen years. Also, "working" taxes amount to an additional $15 per year, payable every two years.

Therefore, it is apparent that United States inventors are not offered equivalent privileges and rights which are given foreign inventors. A foreign inventor may obtain a United States patent and is not required to "work" the same, or pay yearly taxes for its maintenance. Almost all foreign countries require inventors to "work" their inventions immediately or within a few months after obtaining the patent, and in addition to this expense yearly taxes must be paid to the government.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Beauharnois Project on St. Lawrence Approved by Canadian Government

Half a Million Horsepower Will Be Aim of Initial Development at Montreal

THE application of the Beauharnois Light, Heat & Power Company, of Montreal, for approval of its plan to build a power canal between Lakes St. Francis and St. Louis, on the St. Lawrence River, has been granted by the Dominion government. This means that the company is permitted to proceed with a project that has for its object the initial development of half a million horsepower at an estimated cost of approximately $65,000,000.

The scheme involves a diversion of 40,000 sec.-ft., the creation of a canal fourteen miles long, and the erection of a power house which will contain ten generators, each with a capacity of 50,000 hp. Some months ago the project was approved by the Quebec government, which granted the Beauharnois company a lease for 75 years with the restriction that no electric power be exported out of Canada. The plan, however, required final sanction by the Dominion government.

The company, in carrying out its project, is bound to observe a number of stipulations, the most important of which is a provision that should the Dominion authorities at any future time desire to use the canal constructed by the Beauharnois interests as a part of the Greater St. Lawrence Shipway, this substantial link, estimated to cost $16,000,000, will become government property. The company is obliged to construct the canal according to specifications which will make it suitable for ocean-going ships. Under the Order-in-Council granting the application, the company must construct the canal 600 ft. wide on the bottom by 27 ft. in depth at low stage, and at a rate of flow not exceeding 2¼ ft. per sec.

The company is also called upon in case the St. Lawrence waterway project goes through, to build certain aids to navigation in addition to the canal. Electric energy for operation of the locks must be provided free. It is also stipulated that the company must do nothing that will interfere with treaty operations between Canada and the United States.

New Berlin Central Station To Have American Equipment

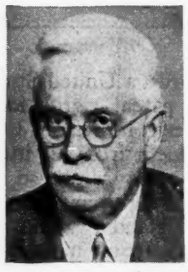
An order from Berlin, Germany, for fuel-burning equipment for the new West Central Station in that city is reported by the American Engineering Company, of Philadelphia. This new station will be at the opposite end of the city from the well-known Klingenburg Station, which is fired by pulverized coal.

The equipment to be supplied includes eight Taylor Stokers, water-cooled furnace walls and ash-removal arrangements. The stokers will have a capacity of 600,000 lb. of steam an hour each and will be twenty retorts wide and 49 tuyères in length. Air for combustion will be heated to 500 deg. F.

This is the third large European order for central-station equipment reported recently by the American Engineering Company, the other two being for the Genoa, Italy, station of the Milan Edison Company, and the Deptford East plant near London.

The orders were obtained through the Taylor Stoker Company, Ltd., of London, a subsidiary.

Men in the News



BION J. ARNOLD

consulting engineer of Chicago, will receive the Washington award for 1929 for pre-eminent service in promoting human welfare through engineering. Mr. Arnold is nationally known as an engineer and inventor. He is a past-president of the American Institute of Electrical Engineers and the Western Society of Engineers and is a member of the American Institute of Consulting Engineers, the American Society of Civil Engineers, the American Society of Automotive Engineers and the Society for the Promotion of Engineering Education.

Indiana Fuel Conference Program Announced

Prof. W. A. Knapp, of the Engineering Extension Department of Purdue University, has announced the program of the Second Annual Indiana Fuel Conference, which will be held at Purdue University, Lafayette, Ind., April 4 and 5. The first day, Thursday, will be devoted to several papers on the subject of domestic heating and to an informal dinner in the evening, at which Dean A. A. Potter, of the Purdue Engineering Department, will be one of the speakers.

On Friday, April 5, several papers will be presented that will be of interest to power engineers. Among them will be "Fusibility of Ash," by A. L. Langtry, vice-president, Commercial Testing & Engineering Company, Chicago; "Recent Developments in Burning Pulverized Coal," by Vernon Leach, Peabody Coal Company, Chicago; and "Fitting the Furnace to the Coal," by A. B. Racht, Holland Furnace Company, Holland, Mich. Other papers will be presented, dealing with special problems connected with Indiana coal.

Soviet Engineers Here On Inspection Trip

A. V. Winter, chief engineer, and B. E. Vedeneev, assistant chief engineer of the Dnieper electric power plant under construction in the Soviet Union, and six other leading Soviet technicians have arrived in this country to study American hydro-electric development and to participate in negotiations with regard to placing orders for several turbines for the plant, with a capacity of 80,000 hp. each. These turbines will be the largest ever installed in hydro-electric plants.

The Dnieper power station will be equipped with ten such turbines and will attain a capacity of 800,000 hp., making it the largest hydro-electric power plant in Europe. The construction of the Dnieper power plant was started two years ago, 60 miles below the City of Vnepropetrovsk, in the Ukraine. Hugh L. Cooper & Company, of New York, has been engaged as consultant on the project, which will involve a total outlay of $100,000,000.

The Dneiper dam, which will be completed within three years, will raise the level of the water in the Dnieper River 37 meters. This will result in raising the water above the rapids which are located several miles above the site of the dam and will make the Dnieper River navigable in that section. Locks will be built connecting the upper and the lower streams of the Dnieper.

Spot * News

THE "POCKET VETO," *or tacit disapproval, which was applied by the President to the Muscle Shoals bill, may come into question if the United States Supreme Court decides that a bill vetoed in this way becomes law if it reaches the President less than ten days before the temporary adjournment of Congress. The Muscle Shoals bill came to the President a few days before the end of the 70th Congress' first session, and was considered killed because of the pocket veto precedent.*

* * *

HISTORIC BULL RUN *in Virginia has succumbed to the demand for electric power. A 500-hp. hydro-electric station has been built there. The project was carried through with the aid of agricultural engineers from the Virginia Polytechnic Institution.*

* * *

THE MUNICIPAL PLANT *of Bennettsville, S. C., is confronted with a demand for 1,000 hp. more industrial load than it can supply. Rather than enlarge the plant the owners seem to prefer the possibility of selling out to private interests.*

* * *

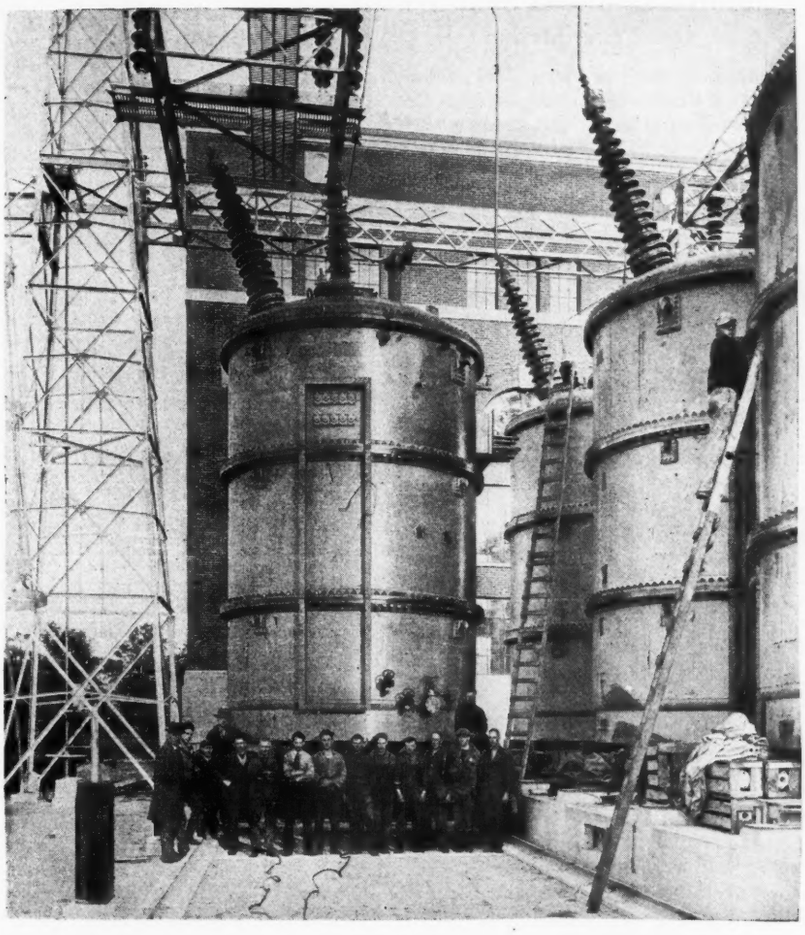
A LOCAL COMPANY *has been formed at Fort Dodge, Iowa, to construct a hydro-electric plant on the Des Moines River for supplying power to Fort Dodge and the surrounding territory. The company is capitalized for $500,000.*

* * *

ANNOUNCEMENT IS MADE *that the Louisiana Oil Refining Corporation has sold its own 1,080-kw. power plant and is now purchasing its entire supply of electric energy from the Southwestern Gas & Electric Company. The load demand is about 500,000 kw.-hr. per month.*

* * *

THE PROJECT *to harness the Jordan River of Biblical fame, will be complete within eight months, it is stated. The project will consist of a 24,000-hp. hydro-electric development backed up by an elaborate system of storage reservoirs and irrigation works.*



A 15,000-kva. transformer being moved into position at the Leaside Transformer Station of the Hydro-Electric Power Commission of Ontario, near Toronto, Can. This transformer station is the terminus of the 220,000-volt transmission line bringing power into the state-owned system from the Paugan, Quebec, plant of the Gatineau Power Company

Gov. Roosevelt Submits Water Power Plan to New York Legislature

On March 12 Governor Franklin D. Roosevelt of New York went before the legislature in Albany with a public ownership water power proposal which he has been working on for some time and which is an outgrowth of the unsuccessful efforts of former governor Smith to obtain legislation authorizing hydraulic development in the state of New York. The present proposal follows the Smith plan to some extent and is in certain respects similar to the recently passed Boulder Dam bill.

A feature of the Roosevelt plan is the appointment of a board of five trustees who will undertake the engineering, political and economic duties in connection with the development of water power within the state. The present proposal originated by the governor is directed at the St. Lawrence development, which was proposed some years ago by private interests but which failed of the approval of Governor Smith. According to the present scheme, the trustees, assisted by competent engineers, would be required to plan, finance and build hydro-electric plants at sites where in their opinion power could be profitably developed. This power would then be sold to private companies for transmission and distribution. The sale of power would be made on a contract basis as distinguished from the rate supervision basis by a commission as at present exercised. A charge to consumers is favored by the Governor which would permit the distributing concerns to realize a net profit of eight per cent on their investment.

Considerable opposition on the part of Republican legislators was forthcoming as soon as the Governor made his proposal, one of the principal stumbling blocks being the provision in the bill by which the Governor would himself appoint the trustees. This was objected to on political grounds. In addition to his message to the legislature the Governor presented a bill embodying the features of his proposal. At the date of writing the bill had not found sufficient support to bring forth any legislator willing to sponsor it.

British 850-Pound Station Nears Completion

The 850 lb. pressure Valley Road power station now being constructed for the City of Bradford (England) Electricity Department will be ready for operation this summer, according to information received from Thomas Roles, City Electrical Engineer and Manager. The plant contains a Babcock & Wilcox boiler suitable for a working pressure of 1,100 lb. and having a normal evaporative capacity of 94,000 lb. per hour. Steam from the boiler is to be passed through an inter-deck superheater and raised to a total temperature of 800 deg. F. It will be used to drive a turbine-generator constructed by the English Electric Company, Ltd.

With a throttle pressure of 850 lb., and a total temperature of 775 deg., this turbine will have an output of 2,266 kw. It is designed to run at a speed of 6,000 r.p.m. and will drive the alternator at a speed of 1,000 r.p.m. through gearing (the alternator speed of 1,000 r.p.m. corresponds to the usual British frequency of 50 cycles).

The steam exhausted from the turbine will be taken to a reheater that is integral with the boiler and from this will pass into the steam main of the station at a pressure of 205 lb. and a temperature of 755 degrees.

This installation is similar to the first high-pressure plant installed at the Edgar Station of the Edison Electric Illuminating Company of Boston in that it consists of a high-pressure turbine and boiler superimposed upon a low-pressure plant. It will, however, differ from that installation in certain details. The Edgar boiler is fired by means of a retort-type stoker. In the Valley Road station a chain-grate stoker will be used. This stoker and the water-cooled arch designed to work in conjunction with it are perhaps the most novel features of the plant. The grate is of an entirely new type just placed on the market by Babcock & Wilcox, Ltd., and is 21 ft. 5 in. wide and 18 ft. long. Water-cooled walls are incorporated at the sides and back of the boiler.

Arizona Solons Oppose Boulder Dam

A resolution denouncing in very strong terms the Boulder Dam project, the Swing-Johnson Act and both the seven-state treaty and the proposed three-state compact has been introduced in the Lower House of the Arizona legislature. The resolution, if adopted, will bind Arizona to fight to the last ditch against the "encroachment of the pernicious activity of those still seeking to rob Arizona of its heritage." The position of Arizona, as outlined in the resolution, is that waters diverted from the Colorado River by California and Mexico should first be used on Arizona lands. The Legislature is asked to "devise positive and concrete plans" for using the water.

With the Society Sections

A. I. E. E., Regional Meeting, at Cincinnati, Ohio, Mar. 20-23, at the Hotel Gibson. Technical program and elaborate entertainment plans.

A. S. M. E., Boston Section. Meeting Mar. 19. Subject: "The Crankless Engine," by A. G. M. Michell.

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Metropolitan Section. Meeting Apr. 1, in New York City. Subject: "Some Aspects of Corrosion in Steel Tube Economizers." Author to be announced.

A. S. M. E., Philadelphia Section. Meeting Mar. 26. Subjects: "Resume of High Steam Pressures as Used in Industrial Plants," P. W. Swain. "Twelve-hundred Pound Holland Station of the Pennsylvania and New Jersey Power System," by E. M. Gilbert, W. S. Barstow Management Association, Reading, Pa. Second Paper: "A Resume of Industrial Power Plants Using High Steam Pressures," by P. W. Swain, Associate Editor, Power.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Florida Section. Meeting, April 10, at Jacksonville, Fla. Subject to be announced later.

Engineers Club of St. Louis. Meeting April 10. Subject: "Pumps and Pumping," by A. T. Hunter, De Laval Steam Turbine Company.

Providence Engineering Society. Meeting March 20. Subject: "Industrial Heating Practice and Fuel Problems," by J. A. Doyle, vice-pres., W. S. Rockwell Company, New York City.

Second Annual Indiana Fuel Conference, at Purdue University, Lafayette, Ind., April 4-5.

A. A. Pope Resigns

A. A. Pope, assistant general commercial manager of the New York Edison Company, has retired after 40 years of service. Mr. Pope was a pioneer in the company and had long been a leader in its affairs. The beginning of his career was with the Edison Electric Illuminating Company of Brooklyn in 1889, but in one year he had removed to New York, and later was one of the four men who started the contract and inspection department.

In addition to handling important contact matters with the public, Mr. Pope was active in the early movement culminating in the present national electrical code, which resulted in a better understanding between the electrical industry and the insurance interests. Mr. Pope also has the honor of being one of the ten men who met to organize the Illuminating Engineering Society. He is a member of the Edison Pioneers and other engineering organizations.

Ontario Makes Large Hydro Appropriations

The Ontario Government has set aside this year a total of $800,000 toward the further development of the Alexander Falls site in the Thunder Bay district. This development, which is situated on the Nipigon River below the Commission's Cameron Falls generating station, is one of the most extensive of the northern Ontario undertakings. Last year the cofferdam for the diversion of the river past the site of the earth dam, was completed on each side of the main channel of the river. The diversion canal to carry the water to the lower river, together with the concrete control works, was also completed.

The provincial Government has also set aside this year $5,566,407 for developments in the Niagara system; $60,000 for transformer stations covering the changing of transmission line voltage and extensions to a number of points in the Georgian Bay system; and some $468,000 for work in the St. Lawrence and Ottawa systems, including $200,000 for a transformer station, Near Smiths Falls, which is about 70 miles from Ottawa.

U. of Wisconsin Fellowships

Dean F. E. Turneaure of the College of Merchanics and Engineering, University of Wisconsin, Madison, Wis., has announced five engineering fellowships for the season 1929-30. Three of these are for a single year's duration and carry a stipend of $750. The other two cover two years, with a salary of $900 and $1,100 for the first and last years, respectively. Recipients of these latter fellowships will be expected to devote at least half their time to assigned research. All fellowships are open only to graduates of engineering colleges of recognized standing.

John Wolff Dies

John Wolff, for many years chief engineer of the Cleveland Electric Illuminating Company, died suddenly of heart disease on March 2. He had been active up to the time of his death and had attended to his duties at the office the day before. He was buried on Tuesday, March 5, at Lake View Cemetery, Cleveland. Mr. Wolff was a bachelor and is survived by two sisters, the Misses Wolff, with whom he lived.

After graduating from Stevens Institute of Technology with the class of 1888, Mr. Wolff spent some time with the United States Electric Company, of Newark, N. J., and then ten years with the Brooklyn Edison Company, followed by two years with the Mahoning Valley Railroad, as chief engineer. Since 1905 he had been with the Cleveland Electric Illuminating Company. At the time of his death Mr. Wolff had been for many years an active member of the Prime Movers Committee of the National Electric Light Association.

Personals

E. H. Striegel has joined the Drake Non-Clinkering Furnace Block Company's organization, of New York City. He was previously with the Furnace Engineering Company.

H. P. Ackerman, who for the last five years has been with the Homestead Valve Manufacturing Company, as district sales manager, has established a manufacturer's agency known as the Steam Specialty Sales Company, headquarters at Charlotte, N. C.

C. D. Buckley has been made sales representative of the W. B. West Company, of Chicago, Ill.

F. E. Bauer, Jr., has been appointed export sales manager for the American Hoist & Derrick Company, whose offices are at 50 Church St., New York City.

Business Notes

The Homestead Valve Manufacturing Company, Coraopolis, Pa., announces the appointment of the Moore-Handley Hardware Company as exclusive representative in the Birmingham, Ala., district.

The American Hoist & Derrick Company, whose main offices are at St. Paul, Minn., has opened a branch office at 139 Townsend St., San Francisco, Calif.

The Foote Bros. Gear & Machine Company corrects the recent statement that the eastern branch office of the company would be in the Woolworth Building, New York City. Instead, this office is at 225 Broadway, New York City.

C. F. Pease Company, Chicago, has established a new Pacific Coast sales office at 501 South Spring St., Los Angeles, Calif. This will be under the direction of R. S. Gibson, western sales manager.

C. F. Bowser Company, Incorporated, has created a new industrial sales district agency which comprises greater New York, Connecticut, and a large part of New Jersey. This will be in charge of E. M. May, with headquarters at the New York offices of the company, 67 W. 44th St., that city.

The W. C. West Company, of Chicago, Ill., makes the announcement that its representative in the Michigan territory is Garrett Burgess, Incorporated, of 5522 Underwood Ave., Detroit, Mich.

C. M. Garland & Company and John A. Scribbins, architect, announce that they have incorporated under the name of Garland & Scribbins and will continue their respective lines as in the past. They are located at 1163 National Bank Building, Chicago, Ill.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Big Wind Inn, Lake of Bays, Ontario, Can., June 27-29. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Trade Catalogs

Castings—A four-page illustrated leaflet has been issued by the Lebanon Steel Foundry Company, Lebanon, Pa., on the importance of castings in the oil fields.

Speed Regulators—The Reeves Pulley Company, of Columbus, Ind., has composed a compact booklet, telling by photographs and printed matter, stories of the applications of its regulators in many different plants.

Air Preheater—Bulletin 129 of the Air Preheater Corporation, New York City, has 32 pages and many illustrations concerning the Ljungstrom Preheater. It is attractively bound in color.

Pumps—Oil pipe-line pumping is the subject of the illustrated leaflet GEA-1077, put out by the General Electric Company, of Schenectady, N. Y.

Synchronous Motors — An eight-page bulletin has been published by the Electric Machinery Manufacturing Company, Minneapolis, Minn., under the title "The Most Efficient Drive for Rubber Mills." This bulletin consists of an article on the application of synchronous motors to rubber-mill drives.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.35@$2.4(
Kanawha.....	Columbus.....	$1.25@1.0(
Smokeless.....	Cincinnati.....	2.15@ 2.2(
Smokeless.....	Chicago.....	2.25
S. E. Kentucky...	Chicago.....	1.35@ 1.60
Steam.....	Pittsburgh.....	1.55@ 1.75
Gas Slack.....	Pittsburgh.....	.90@ 1.1(
Big Seam.....	Birmingham....	1.25@ 1.5(
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.0(
Barley.....	New York.....	1.00@ 1.5(

FUEL OIL

New York—Mar. 14, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Mar. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.45 per bbl. or 42 gal.; 26@28 deg., $1.50 per bbl.; 28@30 deg., $1.55 per bbl.; 30@32 deg., $1.60 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., distillate, 6.25c.

Pittsburgh — Mar. 5, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia — Mar. 8, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati—Mar. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Mar. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Mar. 11, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.52c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Mar. 9, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles — Bartlett Syndicate Building Corp., Rives-Strong Bldg., awarded contract for the construction of a 12 story office and theatre building at Hollywood Blvd. and Argyle St. to William Simpson Construction Co., 1007 Architects Bldg. Estimated cost $1,000,000. Steam heating system, electric elevators, etc. will be installed.

Calif., San Diego—City is having plans prepared for the installation of a sewage system including pumping plant, etc.

Conn., New Britain — H. Doerr, 150 Shuttle Meadow Ave., awarded contract for the construction of a cold storage plant at Spring and Hartford Sts., to Vater & Crannis, 52 Linden St. Estimated cost $40,000.

Ga., Atlanta—Georgia Power Co. plans the construction of a steam electric power generating plant on the Chattahooche river near here, to consist of 4 units of 100,000 hp., a steam turbine generator, 100,000 hp., etc.

Ill., Oak Park—Syndicate, W. R. Grey, c/o Holabird & Root, 333 North Michigan Ave., Archts., is having plans prepared for a 7 story apartment building including either refrigeration or central heating plant at Kenilworth and Ontario Sts. Estimated cost $500,000.

Ill., Chicago—Syndicate, c/o L. F. Urbain, 1254 Lake Shore Dr., is having plans prepared for the construction of a 7 story apartment building including mechanical refrigeration system, etc., at Ashland Ave. and Pratt Blvd. Estimated cost $1,100,000.

Ky., Russell—Chesapeake & Ohio R.R., Richmond, Va., awarded contract for the construction of a freight car, shops and power plant here to Hughes Foulkrod Co., 1505 Race St., Philadelphia, Pa.

La., New Orleans — Sewage and Water Board is receiving bids for extension to drainage pumping station 1. Estimated cost $200,000. G. G. Earl is engineer.

Mass., Attleboro—Attleboro Steam & Electric Co., E. Tregroning, Mgr., 24 South Main St., plans the construction of a power house on West St. Engineer not selected.

Mass., Dedham — Fisher-Churchill Co. awarded contract for the construction of an artificial ice plant on Dwight St., to E. O'Tool, Westwood. Estimated cost $40,000.

Mass., Nantucket—Lynn Gas & Electric Co., 90 Exchange St., awarded contract for addition to turbine room to Aberthaw Co., 80 Federal St., Boston.

Minn., Minneapolis—M. T. Baker Co., 320 Baker Bldg., awarded contract for the construction of a hotel, store, power plant, etc., at Marquette Ave. and 11th St., to Piper, Drake & Schumacher, 316 Baker Bldg. Estimated cost $2,000,000.

Miss., Ellisville—Building Commission, C. Trotter, Secy., Jackson, awarded contract for the construction of a group of buildings including power house and pump house for Mississippi School and Colony for Feeble Minded, here to Massengale & McIntosh Hattiesburg. Estimated cost $247,002.

Neb., Edison—City, plans an election Apr. 2 to vote $18,000 bonds for improvements to waterworks and distribution systems, including pump house, pumps, tank on tower, etc. Estimated cost $18,000. Henningson Engineering Co., 326 Union State Bank Bldg., Cmaha, is engineer.

Neb., Omaha—Swift & Co., 1223 Leavenworth St., awarded contract for a 65 x 100 ft. addition to boiler house to E. E. Gilmore, Suderland Bldg. Estimated cost $40,000.

O., Cleveland—Cleveland, Cincinnati, Chicago & St. Louis Ry., Big Four Bldg., Cincinnati, awarded contract for addition to roundhouse, power house, etc. at Linndale yards to Wellington-Miller Co., 4175 Dearborn St., Chicago, Ill. Estimated cost $450,000.

Okla., Chickasha—City plans an election Apr. 2 to vote $25,000 bonds for waterworks improvements including four deep well, pumping equipment, etc. R. O. Bradley, is engineer.

S. C., Ridgeland — Comrs. of Public Works, W. B. Ryan, Chn., will soon award contract for extensions and improvements to waterworks including well, pumping station, 75,000 gal. tank on tower, etc.

Tenn., Paris—City plans the construction of a new Diesel engine electric light plant. Estimated cost $175,000. Architect not selected.

Tex., Beaumont—Sisters Charity Incarnate Word, c/o F. P. Dodge, Chn. Bldg. Comn., 2216 5th St., awarded contract for the construction of a hospital, nurses home, power plant, etc., to Standard Construction Co., Esperon Bldg., Houston. Estimated cost $450,000.

Tex., El Paso — City plans an election Apr. 9 to vote $700,000 bonds for the construction of a waterworks system including pumping unit, etc. R. E. Thomason, mayor.

Tex., Mercedes—Central Power & Light Co., Frost Bldg., San Antonio, F. Ludden, Dist. Mgr., awarded contract for the construction of a cold storage plant here, to E. Ewing, Mercedes. Estimated cost $55,000.

Tex., Petrolia—City plans an election soon to vote $33,000 bonds for the construction of waterworks and distribution systems including pumping unit, etc.

Wash., Seattle—Puget Sound Power & Light Co., W. D. Shannon, Gen. Const. Supt., Stuart Bldg., plans the construction of a power sub-station in South Benton. Estimated cost $600,000.

Wash., Wenatchee — City Commission, will soon award contract for waterworks improvements including pumping plant, etc. Estimated cost $44,000. F. J. Sharkey, is engineer.

Ont., Ear Falls—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the construction of a hydro-electric development on the English River here to include power house, dams, turbines, generators, transformers, switches, transmission lines, etc. Estimated cost $1,000,000. F. A. Gaby, 190 University Ave., is engineer.

Quebec — Beauharnois Light, Heat & Power Co., application for the construction of a power canal between Lake St. Francis and Lake St. Louis on the St. Lawrence River has been approved by the Dominion Government. The scheme involves a diversion of 40,000 cu.ft. per second, and will enable the company to proceed with an initial power development of 500,000 hp. Estimated cost approximately $65,000,000.

Equipment Wanted

Compressors and Equipment, Pump, Etc.—City of Rusk, Tex., plans to purchase compressor and equipment, pump, etc. for proposed waterworks improvements. Estimated cost $19,000.

Control Equipment—Bureau of Yards & Docks, Navy Dept., Washington, D. C., remote control of electrically-driven centrifugal pumps for salt water pumping plant Navy Yard, Boston, Mass.

Electrical Equipment — Dept. of Public Works, Detroit, Mich., will receive bids until Mar. 27 for electrical equipment including three motor generator exciter sets, switchboard, air circuit breakers, etc. for Connors Creek storm water pumping station.

Electrical Equipment—Louisville Bridge Commission, Louisville, Ky., will receive bids until Mar. 27 for furnishing and installing lighting and electrical equipment for new municipal bridge.

Pumps—W. Sperry, Dir. of Public Service, Grand Rapids, Mich., will receive bids until Apr. 18 for five centrifugal, three plunger type, three sump and two water circulating pumps for proposed sewage disposal plant. Estimated total cost $1,250,000.

Pumps, Etc.—City of Livingston, Tenn., plans to purchase two high duty pumps, etc. for proposed waterworks improvements.

Transformer, Condenser, Etc.—Portland Electric Power Co., F. T. Griffith, Pres., Electric Bldg., Portland, Ore., plans to purchase a 12,500 kw., 51,000 v. transformer, 10,000 kw. rotary condenser, etc. for proposed extensions to plant at Salem, Ore. Estimated total cost $250,000.

Industrial Projects

Ill., Chicago — PIPE FACTORY — Federal Pipe & Supply Co., 900 South Campbell Ave., is having plans prepared for a 2 story factory. Estimated cost $250,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ind., Fort Wayne — RADIO FACTORY and BOILER HOUSE—Steinite Radio Co., awarded contract for a 4 story, 202 x 500 ft. factory and boiler house to Buesching & Hagerman, 402 East Superior St. Estimated cost $400,000.

Me., Lewiston — METAL PLANT and LABORATORY — American Electro Metal Corp., I. P. Schwarzkopf, awarded contract for a 1 story, 110 x 130 ft. metal plant and laboratory to J. A. Greenleaf & Sons Co., 20 Washington St., Auburn, Me. Estimated cost $65,000.

Md., Baltimore — AEROPLANE FACTORY — Berliner-Joyce Aircraft Corp., Hearst Tower, awarded contract for the construction of a 1 story, 140 x 240 ft. aeroplane factory to M. A. Long Co., Long Bldg. Estimated cost $250,000.

Mich., Battle Creek—GRAIN STORAGE—Postum Cereal Co., Cliff St., is having plans prepared for 15 grain storage silos on Cliff St. Private plans. Conveyor and elevator for handling grain will be required.

Mich., Detroit — HEAT TREATING PLANT—National Machine Products Co., 4850 Bellevue Ave., awarded contract for a 1 and 2 story, 35 x 70 and 50 x 162 ft. heat treating plant to Bennige & McKinstrie, 4612 Woodward Ave. Equipment will be installed.

Mich., Detroit — CARBURETOR FACTORY — Zenith Carburetor Co., Lycaste St., is receiving bids for a 2 story, 62 x 118 ft. factory. Donaldson & Meier, First National Bank Bldg., are architects. Miscellaneous machine shop equipment will be required.

Mich., Jackson—ACCESSORY FACTORY—Sparks-Withington Co., North St. and MC. R.R., is having plans prepared for a 3 story, 60 x 250 ft. plant. Estimated cost $150,000. N. Miller, c/o owner, is engineer. Miscellaneous equipment for the manufacture of automobile horns and radiator fans will be required.

N. H., Laconia—FACTORY and BOILER PLANT—Scott & Williams Inc., 299 Union Ave., awarded contract for a 40 story, 60 x 180 ft. factory and boiler plant to Temple & Crane, 80 Federal St., Boston, Mass. Estimated cost $150,000.

O., Cincinnati — MILLING MACHINE FACTORY — Cincinnati Milling Machine Co., Marburg Ave., awarded contract for a 1 story factory on Marburg St., to Austin Co., Dixie Terminal. Estimated cost $80,000.

O., Cleveland—REAMER FACTORY—Kelly Reamer Co., E. W. Putnam, Gen. Mgr., 3705 West 73rd St., awarded contract for a 1 story, 60 x 200 ft. addition to factory, to J. Linder, 15615 Delaware Ave. Estimated cost $40,000.

Pa., Philadelphia—FACTORY and SERVICE BUILDING—General Electric Co., 7th and Willows Sts., awarded contract for a 1 story, 80 x 180 and 50 x 75 ft. addition to factory and service building at 7th and Willows Sts. to United Engineers and Construction Co., Broad and Arch Sts.

Tenn., Old Hickory — WRAPPING PAPER FACTORY—DuPont Cellaphane Co., subsidiary of E. I. DuPont de Nemours & Co., Abbott Rd. and Orchard Park, Buffalo, N. Y., plans the construction of a factory here. Estimated cost $2,000,000 to $3,000,000. Private plans.

Ont., Port Colbourne — NICKEL REFINERY — International Nickel Co., awarded general contract for the construction of three electrolytic refining units to Fraser Brac Co. Ltd., 83 Craig St., Montreal, Que. Estimated cost $1,500,000.